INSTRUCTION MANUAL

SWEEP OSCILLATOR

MODEL 230A

MICRO POWER

OCTOBER 1971

MICRO-POWER DIVISION
WEINSCHEL ENGINEERING CO.
Gaithersburg, Maryland

MP MASTER
MA35894

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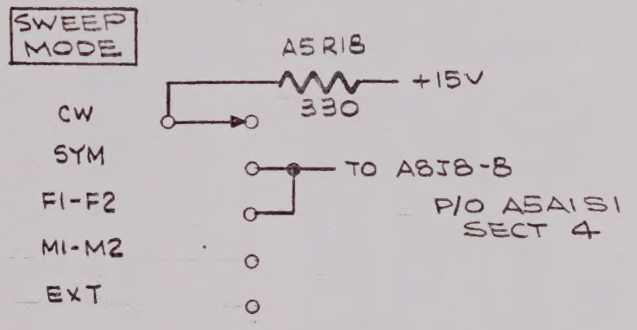
Manual Change

Model 230A

ECN 427 Add Limiting Resistor - A5R18 - 330 ohm 1/4W Comp. (300-331)



ECN 452 Changed A1Q4 to 2N2905A (502-026) and A1Q5 to 2N2905A (502-026)

ECN 462 Add A2R59 10 Meg (300-106) across pins 2 and 6

NOTE: SEE REAR OF MANUAL FOR LATEST MANUAL CHANGES

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SECTION 1-0

GENERAL INFORMATION

1-1. DESCRIPTION. The Model 230A SWEEP OSCILLATOR accepts a series of plug-in RF UNITS. With an RF unit it becomes a solid state electronicallv tunable or sweeping source of precision RF signals, suitable for test and calibration of RF components and systems. Figure 1-1 illustrates the sweep oscillator with a typical RF unit in place. With an RF UNIT installed, the specifications of Section 2-0 of this manual and of the RF UNIT manual will be met.

TABLE 1-1

AVAILABLE RF UNITS

MODEL	FREQ. RANGE, GHz
231A	1-2
232A	2-4
234A	8-12.4
235A	12.4-18
238A,B	0.01-2
241A	1.4-2.5
242A	1.7-4.2
243A	3.6-4.3
244A	5.9-6.5

Additional RF UNITS become available routinely. Please check with your local MICRO-POWER representative for current status.

FIGURE 1-1

SECTION 2-0

SPECIFICATIONS

2-1. 230A SWEEP OSCILLATOR.

FREQUENCY RANGE: Determined by RF UNIT.

SWEEP FUNCTIONS:
End Limit: Between any two calibrated frequencies in band, in either direction, set by F1 and F2 controls.

Marker End Limit: Between any two calibrated frequencies set by the independent M1 and M2 marker controls.
Symmetrical: center frequency set by either calibrated M1 control or external potentiometer. Sweep width adjustable from 0 to 100% of band via continuous, uncalibrated control; or by a nine-position switch providing widths calibrated directly in MHz or GHz, from about 0.25% to 100% of band. Width accuracy ± 10% of sweep width.

External: direct coupled +10V for full sweep, positive voltage increases RF frequency. Response time: 1 msec for full sweep. Provision for external resistance programming. Input impedance 5 k-ohms.

CW Operation: continuously variable calibrated single frequency set by position of M1 control.

MARKER: Two independent adjustable markers displayed either as dips in RF output or externally as video markers. Constant proportion marker width available for sharp marking in narrow-width symmetrical displays.
Accuracy: same as RF UNIT frequency accuracy.
Resolution: better than 0.05% of RF unit bandwidth.
Amplitude: continuously variable.
Output: auxiliary video marker, amplitude -5V, output impedance 5 k-ohms.

SWEEP RATE:
Automatic: decade from 100 sec/sweep, to 0.01 sec/sweep, vernier 10 to 1 continuously variable.
Manual: three-quarter-turn control for sweep between limits set in either end limit or symmetrical sweep modes.

Sweep Dwell Time: delay start and end of sweep.

TRIGGERED SWEEP:
Automatic: recurrent.
Line: line frequency
External: -10V input will initiate sweep.
Single Sweep: front panel momentary switch.

SWEEP OUTPUT: Direct coupled, adjustable from +3 to +10V peak. Sweep indicator light is on during forward sweep only.

PROPORTIONAL OUTPUT:
Switch Selectable:
a. Direct coupled voltage proportional to instantaneous frequency, 0V at low end and 10V at high end of band.
b. Direct coupled voltage proportional to instantaneous frequency, 0V at low end and 40V/octave at high end.

BLANKING OUTPUT:
Operation: RF automatically off during retrace to provide base line except when disabled with rear panel switch.
Output: direct coupled -5V pulse, impedance 5 k-ohms.

PEN LIFT OUTPUT: Relay contact closure during forward-trace portion of sweep.

LEVELED RF OUTPUT:
With internal leveling power variation is as indicated for RF unit. When operated with an external directional coupler and detector the internal feedback amplifier maintains output power variation to within ±0.05 dB, plus couple and detector variation. Provision for power meter leveling from + or - meter output.

RF LEVEL CONTROL:
Level of RF output is controlled on front panel or by external 10 k-ohm potentiometer.

MODULATION:
Amplitude Modulation:
Internal: square wave adjustable from 950 to 1050 Hz with rise time of 10 µsec maximum. On/off ratio greater than 20 dB at rated output.
External: +10V signal increases RF output to rated output (with RF level control set at minimum). Rise and fall time 1.0 µsec unleveled and 10 µsec leveled.
Frequency Modulation: direct coupled wide-band FM input with maximum deviation rate determined by RF unit

GENERAL:

Dimensions: 5-5/8" high x 16-3/4" wide x 13-3/4" deep; rack mounting adaptors furnished for 5-1/4" x 19" rack mount, 11-1/2" deep behind panel. See Figure 2-1.

Ambient Operating Temperature: -10 to +50¼C.
Storage Temperature: -55 to +85¼C.
Weight: 22 lbs not including RF unit.
Power Input: 115/230V ± 10%, 48-420 Hz, approximately 100 VA. Power cord length 8 ft., NEMA connector.

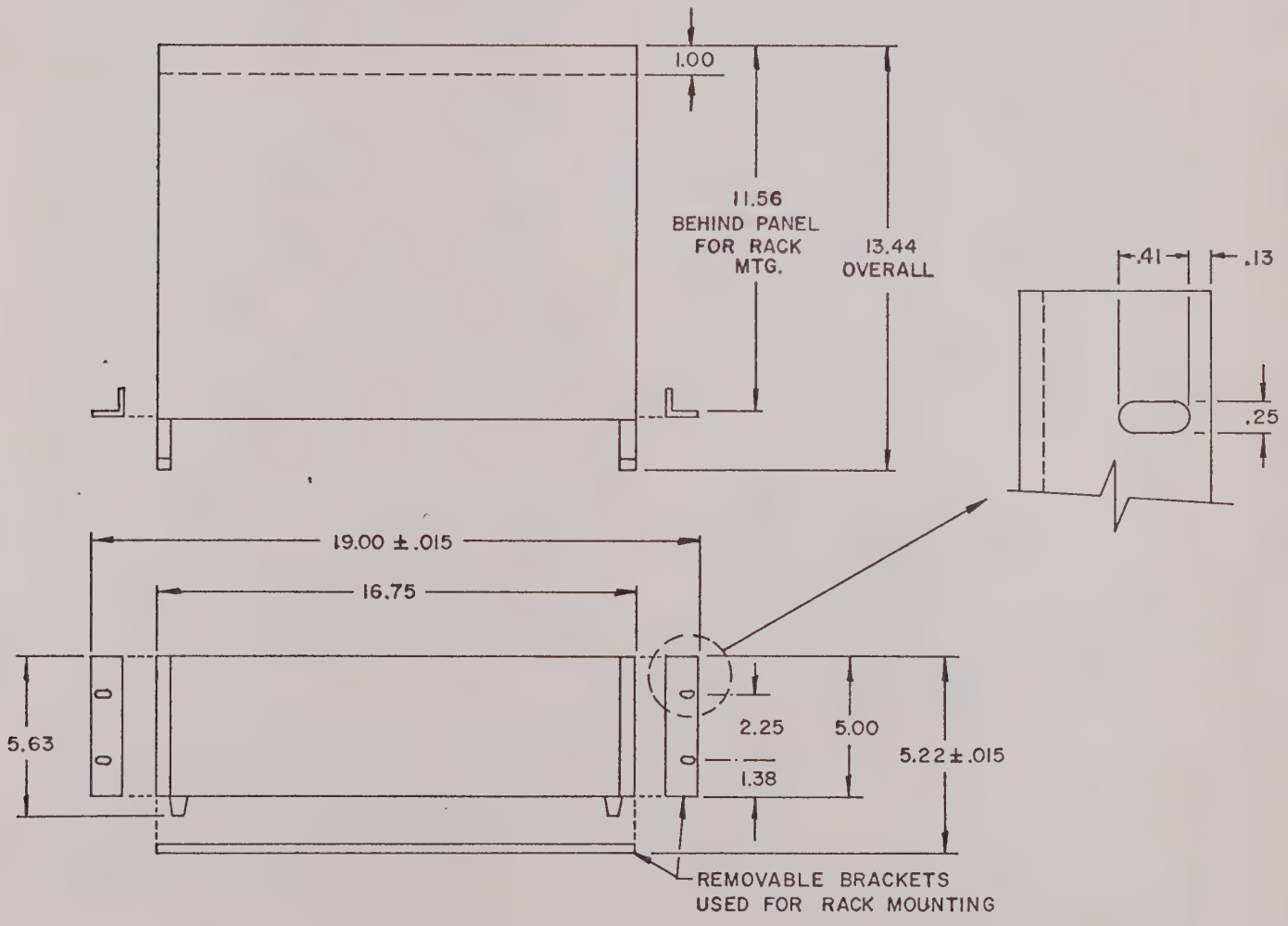


FIGURE 2-1

SECTION 3-0

INSTALLATION

3-1. INSPECTION. Carefully inspect equipment immediately upon receipt. Do not discard packing material until satisfied that equipment is undamaged and operating properly. Should shipping damage be found, report claims to carrier immediately.

The equipment may be tested, if desired, for conformance with the specifications of Section 2-0 of this manual. Prepare for use per Section 3-2, and follow the procedures detailed in Section 6-2.

3-2. PREPARATION FOR USE. The 230A SWEEP OSCILLATOR is straightforward to place in service, having no blowers, airfilters, or unusual precautions.

A single phase AC power source is required at 115 or 230 volts ±10%, from 48 to 420 Hz, capable of providing 100 volt amperes. Important: set the slide control on the rear panel so that "115" or "230" is showing, corresponding to the power source to be used. Install a fuse of the corresponding current rating, as marked on the rear panel.

Install the calibrated frequency scale furnished with the RF UNIT to be used.

3-3. INSTALLATION. A three-conductor power receptacle is recommended so that the three-conductor power cable supplied will keep the instrument exterior at ground potential, minimizing electric shock hazard.

For bench use (See Figure 1-1) the unit is conveniently raised on its four plastic feet. A self storing tiltstand may be locked into position to further raise the front panel for improved access and viewing.

To prepare unit for rack mounting, remove feet and tiltstand; install rack adapters to unit sides and front panel filler strip to unit bottom as illustrated in Figure 3-1. Rack adapters and filler strip are supplied in Accessory Kit (140-002).

3-4. REPACKING FOR SHIPMENT

a) Use the original packing container and cushioning material when possible. Make certain the plug-in is securely locked in position and held there by cushioning material, if shipped installed in the 230A unit.
b) Wrap instrument in sturdy paper or plastic.
c) Place wrapped equipment in a strong shipping container, using a 3-4 inch layer of shock absorbing material around all sides of the instrument to provide a firm cushion and prevent movement inside the container.
d) Thoroughly seal shipping container.
e) Mark shipping container "FRAGILE" to encourage careful handling.
f) If shipping for service attach a tag to unit indicating

    1. Service required
    2. Description of malfunction
    3. Model and Serial numbers
    4. Return address
    5. Authorization to conduct repairs

3-5. WARRANTY. The equipment warranty furnished by Micro-Power is given on a separate form at the rear of this manual.

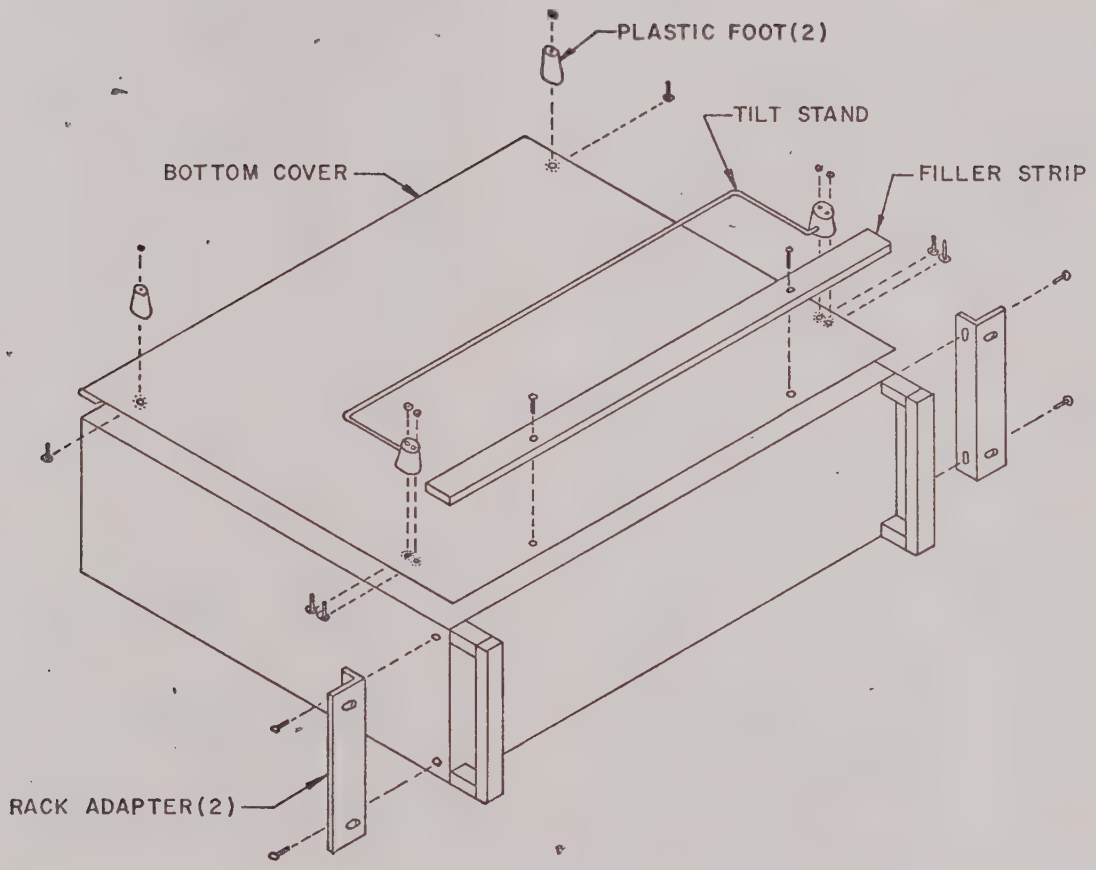


FIG. 3-1
CONVERSION FOR RACK MOUNTING
MODEL 230A

SECTION 4-0

OPERATION

4-1. INTRODUCTION. The Model 230A SWEEP OSCILLATOR (with RF UNIT) is a versatile RF signal source for both CW and swept frequency measurements. It provides three internally generated calibrated sweep functions, CW, and accepts external frequency commands. The frequency range is expandable by adding plug-in RF UNITS, each furnished with a calibrated frequency scale. Internal AM as well as external amplitude programming are provided.

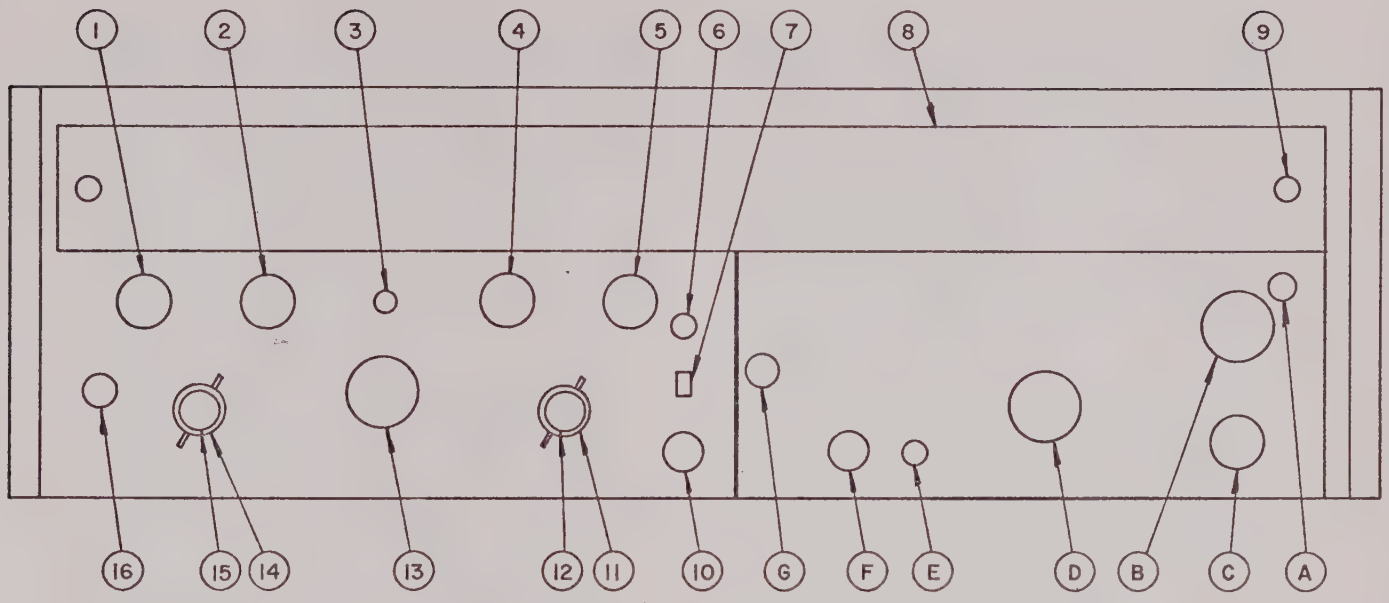
For RF UNIT description, specifications, installation and operation data, principles of operation and maintenance information see the applicable RF UNIT Instruction Manual. The following paragraphs describe operation of the model 230A.

4-2 Controls, Inputs and Outputs. The front panel controls, indicators and connectors are illustrated in Fig. 4-1. Their functions are:

1. F1 control sets the sweep starting frequency for F1-F2 SWEEP FUNCTION. It sets marker frequency in the remaining sweep functions (excluding CW).
2. M1 control sets marker frequency for F1-F2 SWEEP FUNCTION and for EXT SWEEP FUNCTION. It sets the sweep starting frequency for M1-Mr. It sets the center frequency for SYM (M1) SWEEP FUNCTION. It sets the CW (M1) frequency.
3. SWEEP ON Indicator is illuminated during the forward trace of any internally generated electronic sweep (lamp is off during manual sweep).
4. M2 control sets the second marker frequency for F1-F2 and for EXT SWEEP FUNCTION. It sets the sweep limit frequency for M1-M2 SWEEP FUNCTION.
5. F2 control sets the sweep limit frequency for F1-F2 SWEEP FUNCTION. It sets the second marker frequency for M1-M2 and for SYM (M1) SWEEP FUNCTION.
6. 1kHz ⌐⌙ adjustment varies the internal square wave frequency.
7. 1kHz ⌐⌙ ON switch turns the internal square wave on or off.
8. Frequency scale provided with each RF UNIT is secured in place by two fasteners.
9. Scale fastener, knurled and slotted captive screws attached to each scale.
10. SWEEP OUT receptacle provides the internally generated display sweep suitable for oscilloscope or X-Y recorder actuation. It is independent of sweep function, excursion or direction, starting at 0 volts and finishing at a rear panel settable value of +3 to +10 volts. This output is also available at the rear panel.
11. SWEEP TIME selector determines the duration of sweep forward trace in four ranges, or selects MANUAL sweep.
12. SWEEP TIME VERNIER continuously adjusts the sweep forward trace time. When fully clockwise the sweep time is as indicated by the SWEEP TIME selector. When fully counterclockwise the sweep time becomes 10 times longer. This same knob is also the MANUAL sweep control, which manually varies operation of all internal sweep functions from start at full counterclockwise to finish when fully clockwise.
13. SWEEP FUNCTION selects an internal sweep mode, CW, or external frequency command.
14. TRIGGER SELECTOR determines whether the internally generated electronic sweep will be initiated AUTOmatically (free running recurrent), be synced by LINE or by an EXTernal trigger signal, or generate a SINGLE SWEEP.
15. MARKER AMPLITUDE control continuously varies video and RF markers from 0 to maximum.
16. PUSH ON indicating switch is alternately pushed once to turn on, once to turn off primary power.

Figure 4-1

Front Panel Operating Controls



1. F1 Control
2. M1 Control
3. Sweep On Indicator
4. M2 Control
5. F2 Control
6. 1 KHz Adjustment
7. 1 KHz On Switch
8. Frequency Scale

A. Unleveled Indicator
B. RF Level Controls
C RF Output Connector

9. Scale Fastener
10. Sweep Out Receptacle
11. Sweep Time Selector
12. Sweep Time Vernier and Manual Sweep Control
13. Sweep Function Selector
14. Trigger Selector
15. Marker Amplitude Control
16. Push On Indicating Switch

D. Symmetrical Sweep Width Controls
E. Gain Control
F. Ext. Detector Input Connector
G. Lock

A. UNLEVELED Indicator - lights when the RF output is not being leveled across the frequency range in use.

B. RF LEVEL controls - knob sets RF output amplitude; screwdriver adjustment standardizes control action for various external detectors.

C. RF OUTPUT connector - optionally available at rear panel.

D. SYMMETRICAL SWEEP controls - switch selects calibrated peak to peak frequency excursion in SYM mode, or continuously variable sweep width via concentric control knob.

E. GAIN control used to adjust leveler for the particular RF detector and directional coupler to meet the stability requirements of leveler feedback loop. The GAIN control does not affect RF amplitude.

F. EXT DETECTOR INPUT connector accepts the external RF leveling detector output. A rear panel input is also provided. Accomodates negative polarity from crystal detectors or either polarity from RF power meters.

G. LOCK knob secures RF UNIT when rotated clockwise; releases it when rotated counter clockwise.

The rear panel controls and connections are illustrated in Figure 4-2. Their functions are:

1. Terminal Strip A8TB1
   Terminals 1-5 reserved for auxiliary functions. Terminals 6-11 permit use of a remote potentiometer in place of the internal M1 control. A jumper connects 8 and 9; another jumper connects 10 and 11 when the internal control is employed. The jumpers are removed for REMOTE M1 use.

2. PEN LIFT provides a relay closure during the forward trace of the internal electronic sweep when SWEEP TIME ranges 10 sec and 1 sec are selected. This is particularly convenient in activating the writing feature of X-Y recorders only during a sweep. Appropriate dwell time is provided at start and end of sweep for recorder stabilization.

3. BLANKING OUTPUT provides a negative pulse during retrace and prior to initiation of the next forward trace of the internal electronic sweep. Appropriate dwell time is also provided.

4. RF DURING RETRACE switch provides a choice of RF ON or RF OFF during retrace of the internal electronic sweep.

5. EXT SWEEP INPUT accepts sweep voltage commands from 0 to +10 volt in EXT SWEEP FUNCTION mode.

6. SWEEP RESPONSE TIME switch is ordinarily set to NORMAL. When SLOW is selected, the undesired noise accompanying EXT SWEEP signals or internal sweeps is filtered. SLOW RESPONSE TIME may only be used for slow frequency sweeps or for constant frequency. It is automatically provided in CW SWEEP FUNCTION mode.

7. SYM MARKERS switch selects CALIBRATED markers, read from the frequency scale, or uncalibrated RELATIVE markers of constant narrow width in SYM SWEEP FUNCTION mode.

8. DISPLAY SWEEP OUTPUT is identical with the front panel SWEEP OUT connector on the front panel (item 10 of Fig. 4-1).

9. DISPLAY SWEEP AMPLITUDE control sets the maximum voltage available from the DISPLAY SWEEP OUTPUT connector of the rear panel, as well as from the SWEEP OUT connector of the front panel.

10. EXTERNAL TRIGGER INPUT connector accepts -10 volt trigger signals to initiate the internal electronic sweep in EXT setting of the front panel TRIGGER selector.

11. LINE INPUT connector accepts primary power to energize the equipment. The third pin grounds the cabinet for personnel safety when used with the three wire line cord supplied and a three conductor power receptacle.

12. Line voltage selector is set so that the legend "115" or "230" appears, corresponding to the primary power supply voltage used.

13. FUSE rating should be as indicated next to the line voltage selector legend.

14. RF MARKER switch provides amplitude dip marks on the RF output in ON position and eliminates them from the RF output when OFF.

15. VIDEO MARKER OUTPUT provides negative signal when RF frequency and marker frequency coincide. This function is unaffected by the RF MARKER ON-OFF switch.

16. PROPORTIONAL switch selects the scale factor of the PROPORTIONAL OUTPUT voltage. This signal is the voltage analog of RF frequency. It has a constant linear relationship with the output frequency independent of sweep or sweep rate.

17. PROPORTIONAL OUTPUT connector provides a voltage proportional to the instantaneous RF frequency.

A. LEVELER MODE selector switch selects OFF, for unleveled operation, PWR MTR (+ or -) for external sensing using a power meter, EXT XTAL for external sensing using a crystal diode detector. RF units featuring Option -1 have an INT XTAL position, activating the optional internal RF amplitude sensor.

B. EXT DET INPUT same as item F of Fig. 4-1.

C. FM INPUT connector accepts frequency modulation signals of higher frequency than the EXT SWEEP INPUT. See individual RF UNIT manual.

D. AM INPUT connector accepts amplitude modulation signals. For lowest amplitude distortion use XTAL leveling.

E. PULSE INPUT connector accepts pulse input. Shorter rise and fall time can be obtained then via the AM INPUT.

F. EXT CAL INPUT connector accepts external RF marker inputs for RF UNITS featuring controlled markers. See RF UNIT manual.

G. RF OUTPUT connector will be at the rear panel when Option -2 is specified for the RF UNIT.

H. Terminal STrip A7TB3 on the RF UNIT provides a REMOTE TUNING INPUT, remote resistor or voltage control of RF amplitude, and an AUX terminal for special purpose.

4-3. TURN-ON. When the PUSH ON indicating switch is actuated, it will glow and all supply voltages will be on. There is no waiting period for operation.

4-4. SWEEP TIME.

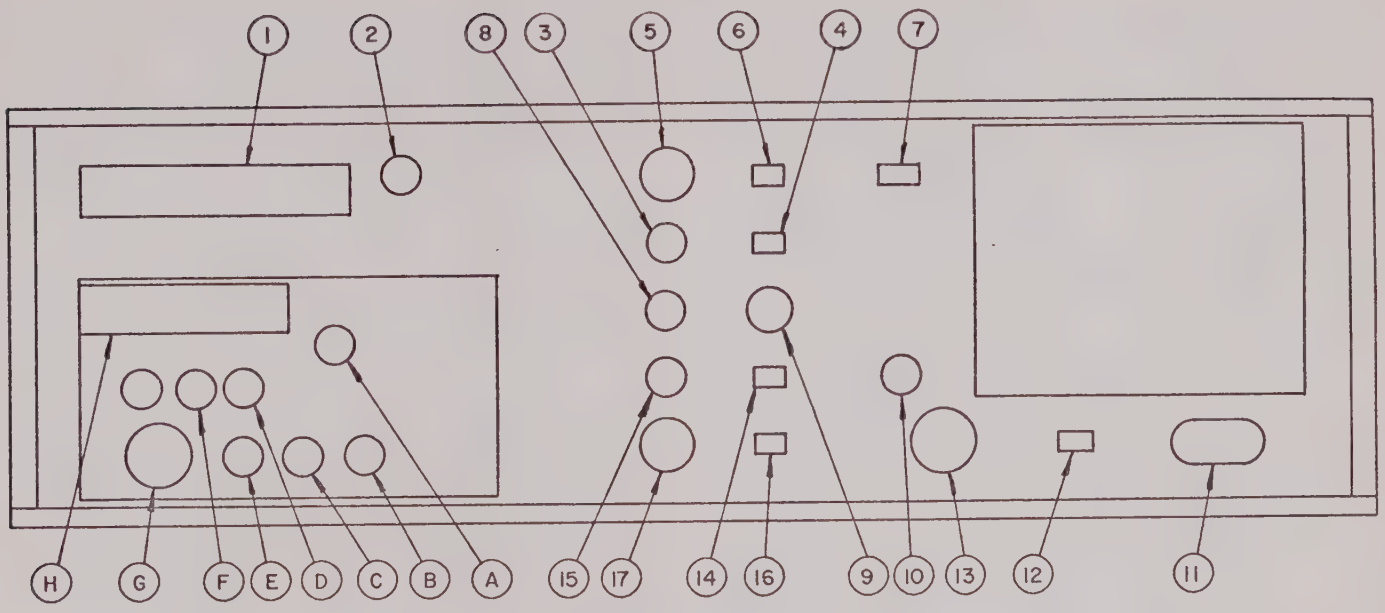
4-5. INTERNAL ELECTRONIC SWEEP. When the SWEEP FUNCTION selected is F1-F2, M1-M2, or SYM M1, the internal electronic sweep provides any selected forward trace time from .01 to 100 seconds. This is accomplished with the SWEEP TIME (sec) decade switch selector together with the concentric 10 to 1 vernier VARIABLE control. The front panel values indicated at each position of the SWEEP TIME selector are obtained with the concentric VARIABLE control in its maximum clockwise CALIBRATED position. When fully counterclockwise the sweep time becomes 10 times as long. The SWEEP ON indicator lamp is illuminated during forward trace of the internal electronic sweep.

4-6. MANUAL SWEEP. The maximum counterclockwise position of the SWEEP TIME (SEC) selector selects MANual sweep.

The internal electronic sweep generator is then disabled and an output from the VARIABLE concentric control substituted. As the control is rotated from its maximum counterclockwise to its maximum clockwise position, the RF signal is varied from its sweep start frequency to its sweep finish frequency.

Figure 4-2

Rear Panel Operating Controls



1. Terminal Strip A8TB1
2. Pen Lift Terminals
3. Blanking Output
4. RF During Retrace Switch
5. Ext. Sweep Input
6. Sweep Response Time
7. Sym. Markers Switch
8. Display Sweep Output

A. Leveler Mode Selector
B. Ext. Det. Input Connector
C. FM Input Connector
D. Am Input Connector

9. Display Sweep Amplitude
10. External Trigger Input
11. Line Input Connector
12. Line Voltage Selector
13. Fuse
14. RF Marker Switch
15. Video Marker Output
16. Proportional Output Switch
17. Proportional Output Connector

e. Pulse Input Connector
F. Ext. Cal. Input Connector
G. RF Output Connector
H. Terminal Strip A7TB1

4-7. SWEEP TRIGGER. Sweep initiation method is determined by the TRIGGER selector.

4-8. AUTOMATIC. In AUTO position, the sweep is AUTOmatically re-initiated upon completion of retrace, i.e. recurrent free-running operation. A short dwell time is provided at sweep start and finish for equilibration.

4-9. LINE. The LINE position triggers a new sweep upon the next line frequency cycle following completion of retrace.

4-10. EXTERNAL TRIGGER. When the EXTernal position is selected and a -10V signal is applied at the rear panel EXTERNAL TRIGGER connector, a new sweep occurs upon receipt of the next negative going external trigger signal following completion of retrace.

4-11. SINGLE SWEEP. To general a SINGLE SWEEP, rotate the TRIGGER selector fully counterclockwise. The control will spring return from its mementary SINGLE SWEEP position, awaiting further actuation.

4-12. SWEEP FUNCTION MODES.

4-13. F1-F2 Mode. In the F1-F2 mode RF frequency sweeps from the F1 to the F2 control setting frequency. Normally the low frequency limit is set by F1 and the high limit by F2, resulting in a sweep from low to high frequency. In addition, the F1-F2 controls can be crossed over each other, thus providing a high to low frequency sweep.

Two calibrated markers are controlled by the M1 and M2 controls, each continuously adjustable over the entire frequency range.

4-14. M1-M2 MARKER SWEEP MODE (Expanded Sweep). The markers may be used to select a portion of the range swept in the F1-F2 mode by positioning the two markers at either side of the portion to be expanded. The SWEEP FUNCTION selector is then placed in the M1-M2 position. The frequency range delineated by the M1 and M2 controls becomes the full width of the swept frequency display.

Two calibrated markers are controlled by the F1 and F2 controls, each continuously adjustable over the entire frequency range.

4-15. SYMMETRICAL SWEEP. The SYMmetrical sweep mode is used where the measurement is more conveniently made in terms of a center frequency and a frequency band about that center. The SWEEP FUNCTION selector is set to SYM M1 position, and the M1 control is set to the desired center frequency. The SYMMETRICAL SWEEP WIDTH control, located in the center of the right hand panel (the RF UNIT), is used to set the total sweep width (peak to peak frequency excursion.

The SYMmetrical mode may be used as an expansion on the F1-F2 mode, when the M1 marker is set to the center of that portion of the F1-F2 display to be expanded.

The SYMmetrical mode is particularly convenient when making narrow band measurements since the frequency excursion is calibrated to within ±10% of the SYMMETRICAL SWEEP WIDTH selected. For narrow sweep width this is substantially more accurate than the markers. SYMMETRICAL SWEEP WIDTH is calibrated in nine convenient steps from approximately 0.2% to 100% of the sweep range of the RF UNIT. The maximum clockwise position activates the concentric control which continuously varies sweep width over the full frequency range.

Two markers are controlled by the F1 and F2 controls, each continuously adjustable. When the rear panel SYM MARKERS switch, item 7 of Fig. 4-2, is set to CALIBRATED, the markers are directly calibrated by the frequency scale, and cover the entire RF UNIT frequency range. When the SYM MARKERS switch is set to its RELATIVE position, the markers become quite narrow and range only over the symmetrical sweep frequency width in use.
The center frequency may also be remotely programmed via the rear terminal strips

A8TB1, item 1 of Fig. 4-2. When jumpers linking terminals 8 to 9 and 10 to 11 are removed, remote voltage or resistance programming controls the center frequency. Voltage from 0 to -10 volts (applied to terminal 9 with respect to terminal 7) will linearly control center frequency over the full range. A potentiometer* or resistor divider placed at terminals 7, 9 and 11 will also determine the center frequency over its full range.

If a number of center frequencies are required, an external switch or push button control can select from a number of remote programming voltages, potentiometers or resistor dividers.

4-16. CW MODE. When the SWEEP FUNCTION control selects CM M1 mode, the RF output frequency will be determined by the setting of the calibrated M1 control. The internal electronic sweep is automatically disabled, and the SWEEP ON light will remain extinguished.

With the equipment operating in its F1-F2 mode, the M1 marker may be positioned at a particular frequency of inerest. When the SWEEP FUNCTION selector is placed in CW M1 position the RF frequency will be at the point previously identified by the M1 marker.

Remote frequency programming may be accomplished via the rear terminal strip exactly as described in paragraph 4-15 above.

4-17. EXTERNAL SWEEP mode. In the EXT position of the SWEEP FUNCTION selector the RF frequency is determined by an external voltage command applied to the rear panel EXT SWEEP INPUT connector, item 5 of Fig. 4-2. Voltage from 0 to +10 volts will linearly control frequency over the full range. The internal electronic sweep is automatically disabled, and the SWEEP ON light will remain extinguished.

Two calibrated markers are controlled by the M1 and M2 controls, each continuously adjustable over the entire frequency range.

*) 1000 ohm recommended value

4-18. SWEEP RESPONSE time Control. When the SWEEP RESPONSE TIME switch, item 6 in Figure 4-2, is set to NORMAL, the response of the RF frequency to sweeping commands (whether internally or externally provided) is constant from DC to moderately high audio frequencies, depending on the RF UNIT in use.

When SWEEP RESPONSE TIME is set to SLOW, the response of RF frequency to commands (whether internal or external) is made quite sluggish. This provides the user with a means to substantially filter unwanted ripple and noise from the frequency command signal. In the SLOW setting of the SWEEP RESPONSE TIME control, only slow changes of RF frequency will occur. Thus, it is suited only for single frequency or for slow sweep speed operation.

The slow response time is automatically provided in CW M1 mode, regardless of the SWEEP RESPONSE TIME selector setting.

4-19. RF LEVEL. The amplitude of RF output is continuously variable by the RF LEVEL control knob, item B of Fig.4-1. Maximum clockwise rotation provides the full RF output power. The associated screwdriver adjustment is used to optimize RF LEVEL control performance, as described in the RF UNIT Instruction Manual. The LEVELER MODE selector, item A of Fig. 4-2, should be placed in the OFF position unless leveled power is to be used (see paragraph 4-8).

4-20. RF POWER LEVELING.

4-21. GENERAL CONSIDERATIONS. The 230A SWEEP OSCILLATOR using any RF UNIT is capable of producing constant RF amplitude across the frequency range. To do this the RF power is leveled, or regulated, at an appropriate point. This is accomplished by electronically comparing the DC level derived from an RF amplitude sampling device with the amplitude command of the RF LEVEL control. The difference, or error, is amplified and applied to a voltage attentuator, which effects any required correction.

The RF LEVEL control sets the maximum

amplitude of RF power across the frequency band. In those portions of the band where there is sufficient RF power, the output will be leveled. In those portions of the band where there is insufficient RF power available, the output will be unleveled, and the UNLEVELED indicator, item A of Fig. 4-1, will light.

The operator can therefore set the RF LEVEL so that a leveled output is obtained across the entire frequency range of the unit, or he can obtain a higher leveled output over a portion of the range where higher RF power is available. Minimum power output of the RF UNIT usually occurs at one end of the frequency range. Therefor, if the RF LEVEL control is adjusted for leveled operation at the band edge, it will be constant while sweeping the entire frequency range.

4-22. INTERNAL LEVELING. RF UNITS having Option -1 feature internal leveling. These units include an internal directional detector consisting of a flat broadband directional coupler with crystal detector, thus requiring no additional equipment to provide leveled RF power. To activate the internal leveling function, simply place the rear panel LEVELER MODE switch, item A of Fig.4-2, in its INT position, and adjust the RF LEVEL control as discussed in paragraph 4-21 above.

4-23. EXTERNAL CRYSTAL LEVELING. Any RF UNIT may be leveled externally using a remote RF amplitude sampler. This is especially desirable at the higher microwave frequencies, to assure flat power directly at the device under test. External leveling may also be used in order to remove the power variations which may otherwise be introduced by a device inserted in the output RF path, such as a filter, long transmission line or an amplifier.

For sweeping at high speeds, e.g. for a flicker-free oscilloscope display, select the XTAL EXT position of the LEVELER MODE switch. The leveling system may then be used with a directional coupler (typically 10dB) and a flat broadband crystal diode detector. A directional detector may also be used, which consists of a coupler-crystal combination in a single package. Detector output of 50 millivolts is typical for normal operation.

For best results over a frequency range of less than 2:1, a low pass filter with cutoff frequency at the high end of the desired band may be inserted before the directional coupler. The influence which any small harmonic content of the RF signal might have on leveling is thus prevented.

4-24. POWER METER LEVELING. The ultimate in leveling accuracy and flatness across a broad band is obtained when an RF power meter is substituted for the crystal detector of paragraph 4-23 above. The long response time of power meter thermistor mounts restricts SWEEP TIME selection to the two slower ranges, 1 SEC and 10 SEC. These ranges are also suitable for an XY PLOTTER graphic recorder, useful when a long persistence or memory oscilloscope is not used.

The power meter should have an output of the order of 1 volt or 1 milliampere. Either polarity may be used with the LEVELER MODE switch set correspondingly. A 10 dB directional coupler is typical, and a low pass filter may be used, exactly as in XTAL leveling. Leveled output power may be read from the power meter, by adding the directional coupler's coupling factor in dB. Power will depend both on the front panel RF LEVEL control setting, and on the range selected for the power meter. The GAIN control, item E of Fig. 4-1, may need to be readjusted when resetting the power meter range switch.

When square wave modulation is used PWR MTR leveling action will maintain constant average power. Since the duty factor of the internal square wave is 50%, the peak RF power will be twice the value indicated by the average reading RF power meter.

To minimize transients at the start of sweep, it is recommended that the RF DURING RETRACE switch, item 4 of Fig.4-2, be placed in its ON position. See Section 4-27 for additional comments.

4-25. MARKERS. The 230A SWEEP OSCILLATOR generates two independent calibrated frequency markers in each sweep mode. These are available as a negative video signal at the VIDEO MARKER OUTPUT connector, item 15 of Fig. 4-2. The marker waveform may be displayed on a second channel of an oscilloscope or recorder, as an oscilloscope intensity variation, or to activate systems such as a network analyzer.

When the RF MARKER switch, item 14 of Fig. 4-2, is placed in its ON position, the markers are displayed as a sharp dip in RF power.

Marker amplitude may be set by the continuously adjustable MARKER AMPLITUDE front panel control, item 15 of Fig. 4-1.

4-26. AMPLITUDE MODULATION

4-27. BLANKING DURING RETRACE. When the RF DURING RETRACE switch, item 4 of Fig. 4-2, is placed in its OFF position, the RF power is turned off during retrace of the internally generated sweep, and provides a zero power reference base line for the RF display. Dwell time is provided at both start and finish of sweep.

In its ON position, the RF DURING RETRACE CONTROL causes RF power to be present during retrace as well as forward trace. This is useful for power meter leveling and for chart recorder operation because it avoids large amplitude changes at the beginning and end of sweep.

A negative video pulse, coincident with the retrace, is provided at the BLANKING OUTPUT connector, item 5 of Fig. 4-2. Furthermore, a contact closure during forward trace is provided at the PEN LIFT terminals, item 2 of Fig. 4-2. The PEN LIFT provision should be used with recorders having that feature to disable writing during retrace. The pen lift terminals automatically remain open in MANUAL sweep mode, the .1 and .01 SEC SWEEP TIME ranges, and when primary power is off.

4-28. INTERNAL SQUARE WAVE. The internal 1 kHz square wave feature, especially useful with a tuned detection amplifier, may be activated in any mode. The front panel 1 kHz screwdriver adjustment and switch, items 6 and 7 respectively of Fig. 4-1, afford means to set the square wave frequency from 950 to 1050 Hz, and to turn it on or off. When ON, 100% modulation is provided. Peak power is identical with square wave off power in leveling OFF or XTAL. In POWER METER leveling mode, it is the average power which remains the same, possibly necessitating re-setting the RF LEVEL to maintain peak power within the RF UNIT'S maximum output capability.

4-29. EXTERNAL AM. Amplitude programming or modulation may be applied to the RF UNIT rear panel AM INPUT connector, item D of Fig. 4-2. Signals applied here are directly mixed with the output of the RF LEVEL control. Frequence response is maximum when LEVELER MODE selector is OFF. Amplitude distortion of the modulation is minimum when XTAL leveled. Power will be linear with AM INPUT when POWER MTR leveled, but frequency response rather limited.

The RF LEVEL control may be adjusted to center the dynamic range of AM INPUT modulating signals as desired.

4-30. EXTERNAL PULSE. For the shortest possible rise time, pulse modulation should be applied to the RF UNIT rear panel PULSE INPUT connector, item E of Fig. 4-2. Set RF LEVEL to maximum counterclockwise so that RF amplitude will be low except during a pulse. The LEVELING MODE selector should be OFF.

4-31. DISPLAYING SWEPT FREQUENCY MEASUREMENTS. For rapid evaluation or adjustment of a device under test, the cathode ray oscilloscope is usually the most convenient display means, using a flat broadband crystal detector. A simple setup of this type is illustrated in Fig. 4-3.

The RF output passes through a pad, the device being tested and the crystal detector, which converts it to a video signal applied to the oscilloscope vertical amplifier. The pad is optionally included to secure improved source match and low enough power level so that the detector operates in its square law

region. The front panel SWEEP OUTPUT or rear panel DISPLAY SWEEP OUTPUT drives the oscilloscope horizontal input. Display width may be adjusted by the oscilloscope horizontal gain, the 230A rear panel DISPLAY SWEEP AMPLITUDE control, or both.

Measurements will be enhanced by leveling, as discussed in paragraphs 4-20 through 4-24 above.

The X-Y graphic recorder is another useful display, which provides a permanent record. Figure 4-4 shows a simple test set-up. Operation is similar to that with an oscilloscope, except that the SWEEP TIME selector will be set to the 1 or 10 SEC sweep time range, and sweep time set compatible with recorder response time. In addition, if the recorder has pen lift or equivalent writing enable-disable feature, it should be connected as illustrated. Then the chart paper will only be marked during the sweep forward trace.

The recorder X and Y scale factors and zero suppression may be conveniently adjusted by placing the SWEEP TIME control in MAN and rotating the concentric continuously VARIABLE knob. The PEN LIFT feature prevents chart marking until an electronic sweep is initiated.

See sections 4-20 through 4-24, and 4-27 for additional comment.

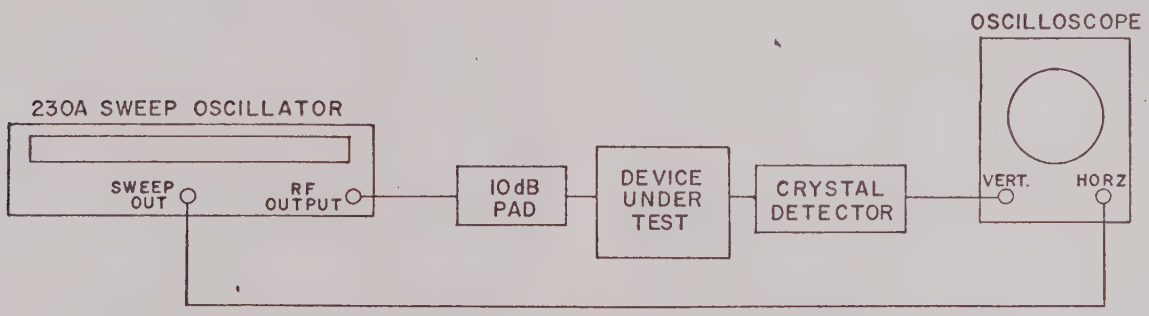


FIGURE 4-3

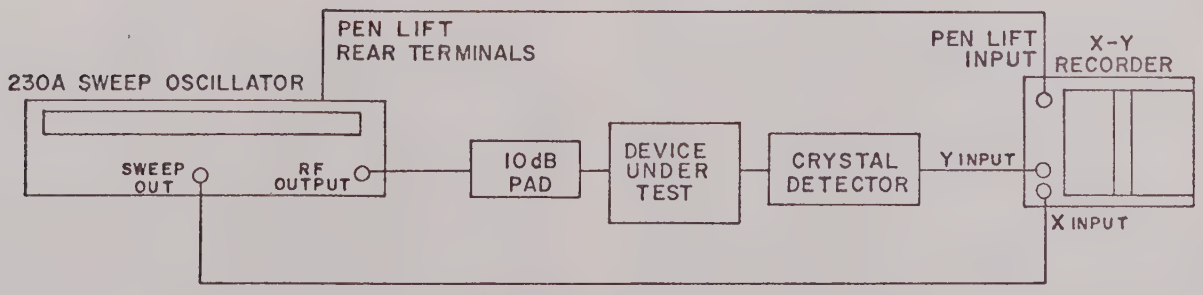


FIGURE 4-4

4-32. REMOTE PROGRAMMING. The 230A SWEEP OSCILLATOR may be remotely controlled by several useful techniques to externally determine RF frequency and power level by using either voltage or resistance control.

To control frequency by a 0 to +10 volt signal, either DC or a special waveform, apply it to the rear panel EXT SWEEP INPUT and place the front panel SWEEP FUNCTION selector in EXT. The F1 and F2 controls will be inoperative, but calibrated markers M1 and M2 operate normally.

To control frequency with a 0 to -10 volt signal remove the jumper form terminals 8 and 9 of the main frame rear panel terminal strip A8TB1, and apply the signal to terminal 9, signal return to terminal 7. If the shield of shielded leads is to be connected to the 230A, use terminal 6 for that purpose. Place the SWEEP FUNCTION selector in CW M1. If the remote signal is to be modulated or rapid response is required set the SWEEP FUNCTION in SYM M1. The internal electronic sweep will then operate normally, providing a calibrated symmetrical sweep about the remotely programmed center frequency. The M1 control will be ineffective; F1 and F2 controls will control the two markers normally. The internal electronic sweep may be disabled by setting the SWEEP TIME control to MAN or the TRIGGER selector to EXT, and placing the SYMMETRICAL SWEEP WIDTH control at minimum.

To control frequency by a remote resistor divider or potentiometer (1,000 Ω recommended), remove both jumpers from the mainframe rear terminal strip A8TB1 terminals 8-9 and 10-11. Connect the remote resistance divider to terminals 7,9 and 11 as illustrated on the rear panel. Then proceed as in the preceding paragraph. Additionally, since the remote resistance divider replaces the M1 control, this connection permits remote marker control in F1-F2 mode, and remote sweep start control in the M1-M2 mode.

Voltage control of frequency is also available via the RF UNIT rear terminal strip A7TB3. This input may be used either alone or in conjunction with any of the aforelisted techniques of remote frequency control. When the jumper is removed from A7TB3 terminals 2 and 3, a voltage input applied to terminal 2, with signal return to terminal 3, operationally adds to the RF frequency in every mode. This may be especially convenient as a vernier about a preset frequency. A 10 volt change spans the entire RF UNIT frequency band, frequency increasing for negative going voltage.

Wideband remote frequency programming, e.g. phase lock, must be applied via the RF UNIT rear panel FM INPUT connector. Frequency deviation is superimposed on the RF frequency determined by the other inputs and controls.

Frequency may be digitally controlled via an external digital to analog converter. Format, buffering, polarity and zero suppression may be chosen to fit each application.

When only fixed or slowly varying frequency commands are employed, the discussion of paragraph 4-18 may be applicable.

RF amplitude may be remotely programmed via either voltage or resistance divider control.

To control amplitude by voltage, simply apply the command signal to the RF UNIT rear panel AM INPUT connector. A 10 volt change spans the entire available amplitude range, with power increasing for a positive going signal. The AM INPUT command is operationally added to the front panel RF LEVEL control. Thus RF power setting is determined by both the DC level of the AM INPUT signal, and the position of the RF LEVEL control.

Voltage control of RF amplitude may alternatively be applied in substitution for the RF LEVEL control. Remove the jumper from RF UNIT rear panel terminals 4 and 5 of A7TB3, and apply the command signal to terminal 5, signal return to terminal 3. Increasing voltage from 0 to +10 volts causes RF power to increase.

To control RF amplitude by a remote re-

sistor divider or potentiometer (10,000 Ω recommended), remove both jumpers from the RF UNIT rear terminal strip A7TB1, terminals 4-5 and 6-7. Connect the remote resistance divider to terminals 3, 5 and 7 as illustrated on the rear panel.

Amplitude may be digitally controlled via an external digital to analog converter having suitable format, buffering and polarity.

SECTION 5-0

PRINCIPLES OF OPERATION

5-1. GENERAL BLOCK DIAGRAM. A simplified overall block diagram of the 230A sweep oscillator is shown in Fig. 5-1. The basic functions of the mainframe are illustrated with a generalized RF UNIT. The frequency of the RF OUTPUT is controlled by the amplitude of the tuning signal applied to the electrically tunable RF oscillator. The amplitude of the RF OUTPUT is controlled by the amplitude of the signal applied to the diode modulator.

The RF frequency range of the RF UNIT is covered by sweeping the output of the (regulated) tuning supply. The SWEEP AMPLIFIER section drives the TUNING SUPPLY REGULATOR with the required waveform, determined by the settings of the front panel controls. The waveshape produced by the SAWTOOTH OSCILLATOR is modified by the SWEEP LIMITER section. The SAWTOOTH OSCILLATOR also supplies synchronous signals such as retrace blanking. The internally generated sweep is initiated by the SWEEP TRIGGER section according to the front panel selector setting.

The amplitude of the RF OUTPUT is adjusted over its control range by the electrically controllable attenuation of the DIODE MODULATOR. The LEVELING AMPLIFIERS section drives the modulator with a control current intensity determined by the RF LEVEL control. When leveling is in operation, a portion of the RF output is sampled by the DIRECTIONAL COUPLER, detected in the DETECTOR, and applied to the LEVELING AMPLIFIERS section as a negative feedback control signal. As the RF frequency is varied the leveling control loop maintains the DETECTOR output constant. The amplitude variation of the RF OUTPUT therefore depends only on the characteristics of the DIRECTIONAL COUPLER and DETECTOR combination.

The FREQUENCY MARKER GENERATOR compares sweep voltage with marker control settings to develop marker signals at the corresponding RF frequencies. The SQUARE WAVE GENERATOR, the retrace blanking signal, and the markers, when individually activated by the operator, are combined in the OR GATE, and applied to the leveling amplifier as modulation.

Additional controls, inputs and outputs enumerated in paragraph 4-2 are discussed in the detailed paragraphs of Section 5-0 below.

5-2. SAWTOOTH OSCILLATOR. Sweep generation is accomplished by the combination of sweep trigger, sawtooth oscillator, sweep limiter and sweep amplifiers. Fig. 5-2 is a simplified schematic diagram of the sawtooth oscillator, whose waveform is processed to develop all internally generated sweep waveforms.

Placing the SWEEP TIME (SEC) switch in its .01, .1, 1 or 10 position places a capacitor from output to input of IC1, so that together with input resistors an INTEGRATOR circuit is formed. Forward trace is developed by +15V REF voltage applied to IC1 via A5A2R1 and A5R15. The output of IC1 increases linearly negative until the desired voltage is reached.

Integrator action is transferred from forward trace to retrace when the BINARY, or bistable multivibrator, state is reset. During forward trace Q4 is conducting, maintaining Q5 cutoff. However, when the output of IC1 reached -12 volts the -12V comparator formed by R27, R26 and CR6 drives the base of Q5 negative, causing it to conduct. The BINARY resets its state so that Q4 is cut off and Q5 conducting. Consequently, the collector voltage of Q4 becomes negative. A large re-charging current is thus applied via R22 and CR8 to the integrator, causing it to retrace by reversing the direction of current flow. CR11 terminates the sawtooth retrace at about 0 volts.

External or internal trigger signals, selected by TRIGGER selector A5S1, drive the base of Q5 positive via CR5 to set the BINARY and initiate the next forward trace to repeat the process.

Generation of the blanking waveform is accomplished by taking the collector output from Q4, which is 0 during trace and ne-

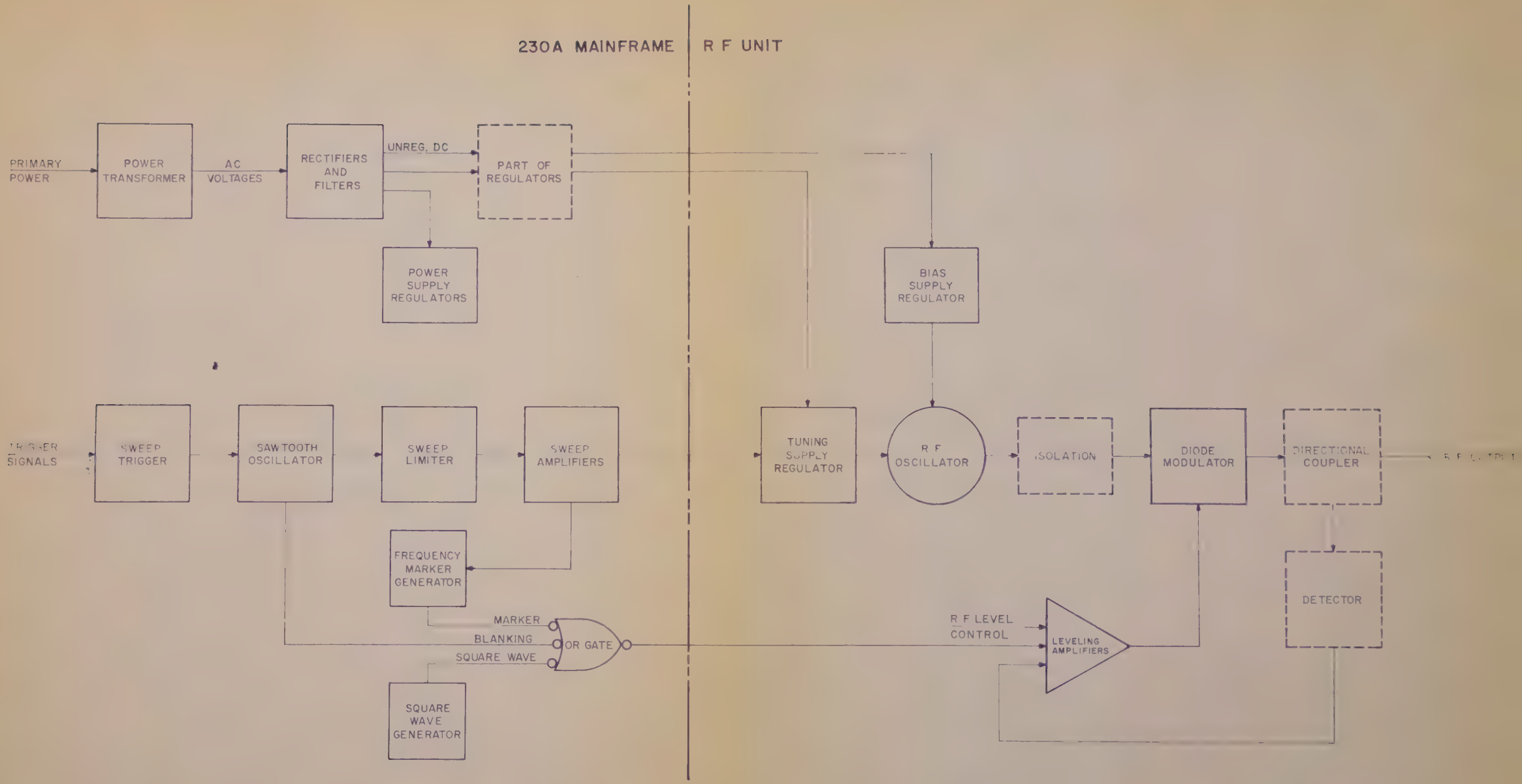


FIG 5-1
GENERAL BLOCK DIAGRAM
MODEL 230A

P/O A1 ASSEMBLY

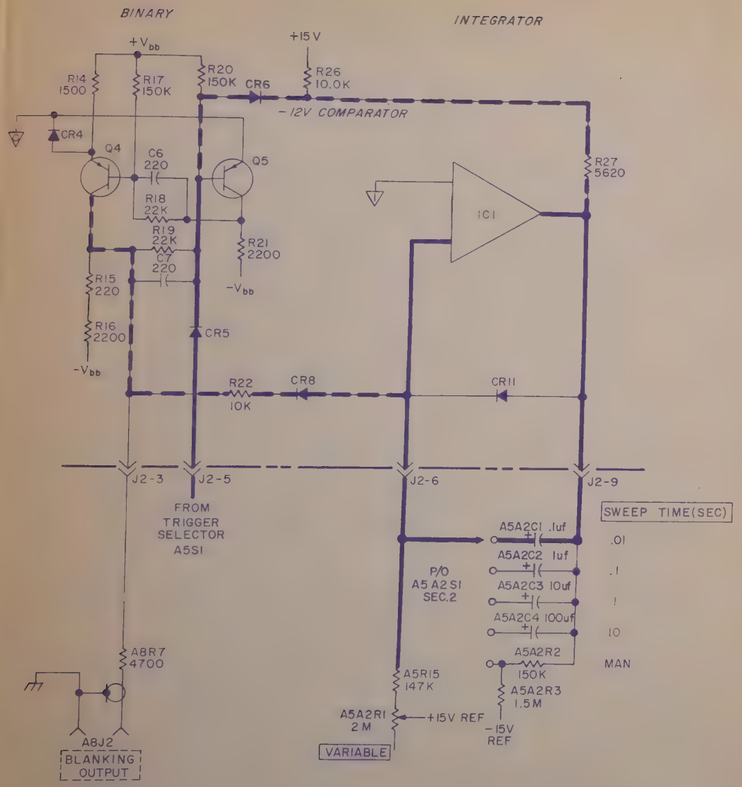


FIG.5-2
SAWTOOTH OSCILLATOR
SIMPLIFIED SCHEMATIC DIAGRAM
MODEL 230A

P/O A1 ASSEMBLY

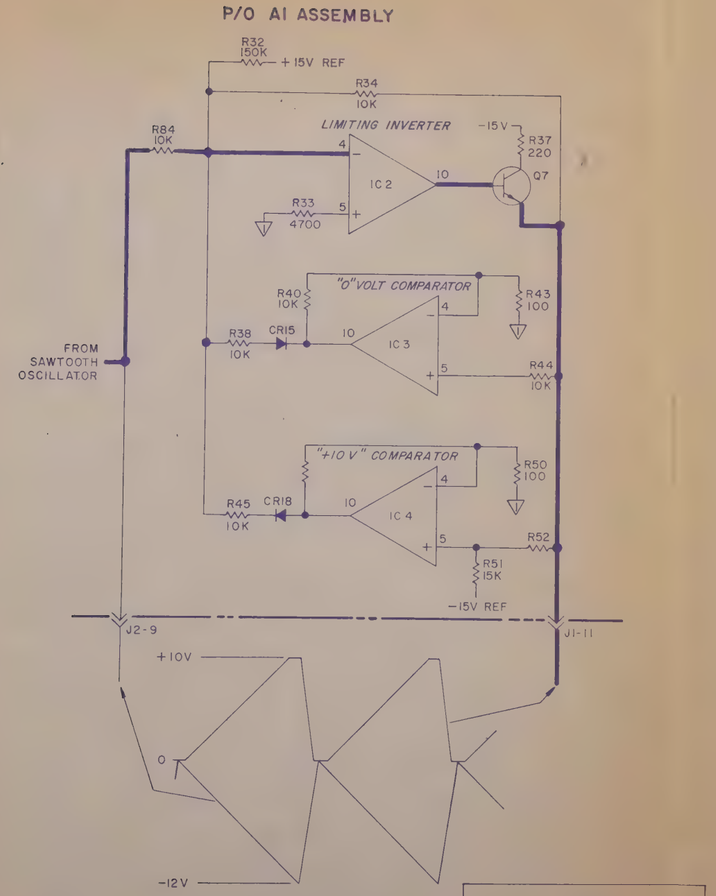
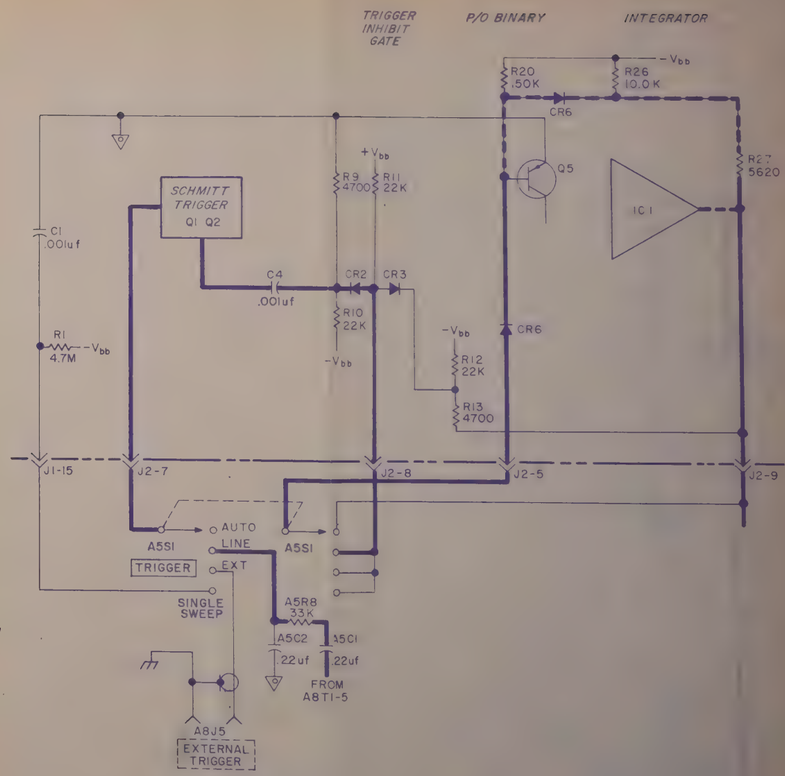


FIG. 5-3
SWEEP LIMITER
SIMPLIFIED SCHEMATIC DIAGRAM
MODEL 230A

P/O A1 ASSEMBLY



NOTE REFER TO FIG. 8-2 FOR COMPLETE SCHEMATIC

FIG. 5-4
SWEEP TRIGGER
SIMPLIFIED SCHEMATIC DIAGRAM
MODEL 230A

gative during retrace. BLANKING OUTPUT is isolated by A6R7.

Electronic manual sweep is developed when the SWEEP TIME selector is placed in MAN position. Instead of a capacitor the resistor, A5A2R2, becomes the feedback element for IC1, forming a feedback amplifier. Adjustment of A5A2R1 causes the output potential of IC1 to cover the same voltage range as that obtained in sweep generation.

Lamp driver Q3 (see complete schematic Fig. 8-2.) conducts whenever Q4 does, illuminating the SWEEP ON lamp A8DS2 during forward trace of the internal electronic sweep. Normally open PEN LIFT relay A1K1 is energized by transistor Q6 only during forward trace, if its circuit is completed via Section 1 of SWEEP TIME switch A5A2S1 by selecting the 1 or 10 (SEC) positions. In its MAN position, section 1 of the SWEEP TIME switch connects the tap on transistor Q4 collector load to nearly zero volts, holding the BINARY in its forward trace state without illuminating the SWEEP ON lamp. Section 2 of the SWEEP TIME switch has another arm in addition to the one which selects the capacitor or resistor to be connected to IC1's input. This second arm is used to automatically discharge each integrator capacitor when changing SWEEP TIME (SEC) range. Another detail not included in the simplified schematic Fig. 5-2 is the RF DURING RETRACE switch, which applies blanking signal to the OR GATE of Fig. 5-1 in its OFF position.

5-3. SWEEP LIMITER. Dwell (or equilibration) time is provided at the start and finish of the internally generated electronic sweep by limiting the sawtooth so that its sharp peaks are flattened. Figure 5-3 is the simplified schematic diagram of the SWEEP LIMITER section.

The negative waveform from the sawtooth oscillator is inverted by IC2 and Q7, connected as an operational amplifier with gain of -1. Resistor R32 applies a DC shift to the input, "centering" the 12 volt peak to peak input waveform. Output from Q7 is not permitted to go negative by the action of IC3, the "0" volt COMPARATOR. When its input to pin 5 goes negative by only a few millivolts, output from pin 10 becomes negative by several volts, causing CR15 and R38 to conduct. This negative current is applied to the input of IC2, overpowering any further increase in input. Thus, the most negative output permissible from Q7 is almost exactly 0 volts.

Similarly, the "+10V" COMPARATOR, IC4, guards against output from Q7 exceeding +10 volts. Output is compared via a 10 k resistor with -15 volts through a 15 k resistor. Even a few millivolts more positive than 10 volts will cause IC4 to produce a positive corrective signal of several volts. Applied to the input of IC2 via R45 and CR18, this correction prevents the output from Q7 from exceeding +10 volts.

For comparison the sawtooth oscillator waveform, input to the SWEEP LIMITER, is shown together with the inverted and limited output waveform at the bottom of Figure 5-3.

The DISPLAY SWEEP OUTPUT is taken from the SWEEP LIMITER output, providing a display sweep synchronous with the internally generated electronic or manual sweep* of RF UNIT frequency. Its amplitude varies from 0 volts at the start of sweep to a settable voltage at sweep finish, adjustable by the rear panel DISPLAY SWEEP AMPLITUDE control from +3 to +10 volts.

5-4. SWEEP TRIGGER. As described in section 5-2, the SWEEP OSCILLATOR BINARY becomes reset on completion of forward trace, and remains reset until again set by a sweep initiating trigger signal.

The choice of trigger is operator controlled by setting the sweep TRIGGER selector A5S1, as illustrated in Fig. 5-4.

In EXT position, when a negative going signal is applied to the rear panel EXTERNAL TRIGGER connector, it is applied to the SCHMITT TRIGGER circuit, where its rise time and amplitude are standardized. The positive going output is differentiated by C4 and R9, then applied to the TRIGGER INHIBIT GATE formed by CR2 and CR3, This gate allows the trigger pulse

*in F1-F2, M1-M2, and SYM M1 modes.

to pass only when the INTEGRATOR output has completed its retrace. Then the junction of CR2 and CR3 is pulled up by R11, and applied via the right hand portion of A5S1, the TRIGGER selector, via CR6 to Q5, setting the BINARY into the forward trace state.

in LINE position of the TRIGGER selector a sample of line frequency is taken from transformer A8T1 via A5C1 and A5R8, filtered by A5C2 and standardized by the SCHMITT TRIGGER. After completion of retrace, the next line frequency cycle will initiate a sweep.

For SINGLE SWEEP generation the negative voltage stored in C1 (via R1) is applied to the SCHMITT TRIGGER by placing the TRIGGER selector in its momentary SINGLE SWEEP position.

Automatic recurring sweep results when the TRIGGER SELECTOR is placed in AUTO because the integrator output is then used directly as the signal to set the BINARY. Upon retracing from negative to zero volts the integrator output becomes positive enough to cut off Q5 via CR6.

5-5. SWEEP AMPLIFIERS. The internally generated electronic sweep tuning waveform applied to the TUNING SUPPLY REGULATOR is developed in the SWEEP AMPLIFIERS section by processing the SWEEP LIMITER waveform in accordance with operator seselected control settings. Each SWEEP FUNCTION switch setting interconnects the amplifiers and tuning control potentiometers in a distinct mode.

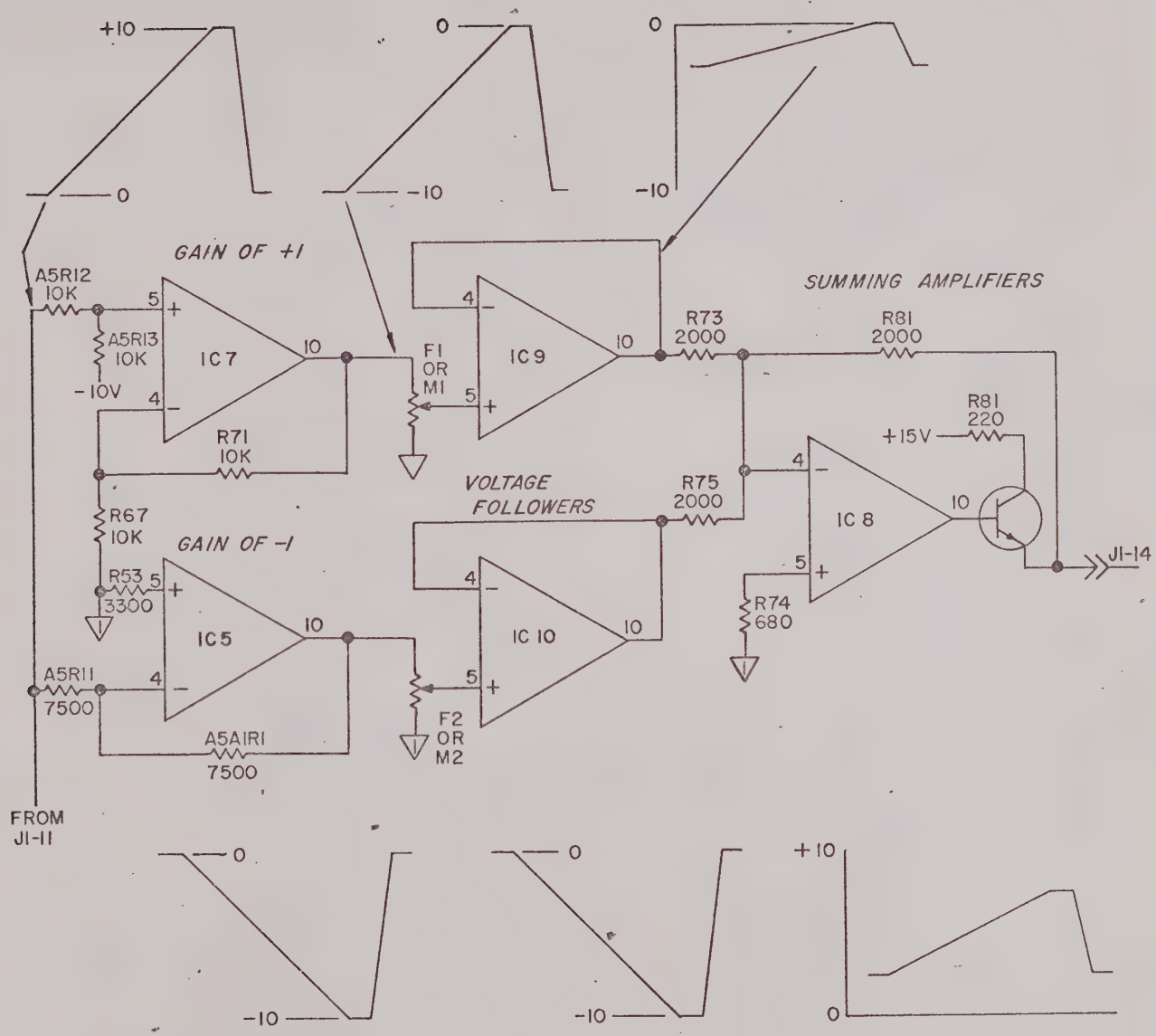
5-6. F1-F2 (and M1-M2) MODE. The sweep waveform required at the input to the TUNING SUPPLY REGULATOR in the F1-F2 (or M1-M2) mode has its start and finish voltages adjustable to correspond with the F1 and F2 (or M1 and M2) frequency indicators of the frequency scale. Figure 5-5 shows how this is accomplished. Voltage divider A5R12 and A5R13 divide the sweep waveform by two, and shifts its dc level. Amplifier IC7 doubles the result, so that the combination has a gain of +1 with a DC shift. The input to IC9 is a portion of IC7's output determined by the setting of the F1 (or M1) potentiometer. Simultaneously IC5 inverts the sweep waveform since it has a gain of -1 in this mode. Potentiometer F2 (or M2) selects a fraction of the inverted waveform proportional to its setting, and applies that fraction to IC10. The outputs of IC9 and IC10, the VOLTAGE FOLLOWERS, are added in IC8, a SUMMING AMPLIFIER with gain of -1 for each input. The starting value of sweep voltage is thus proportional to the position of the F1 (or M1) potentiometer, and the finish value to the position of the F2 (or M2) potentiometer.

The direction of sweep is from F1 (M1) to F2 (M2). In normal operation F1 (M1) is lower than F2 (M2). However, F1 (M1) can be set higher in frequency than F2 (M2) by cross-over of their indicators. The output frequency will then sweep from the higher to the lower frequency.

5-7. SYMMETRICAL SWEEP MODE. In the symmetrical sweep mode the SWEEP AMPLIFIERS are interconnected as shown in Fig. 5-6. The sweep waveform is combined with the DC level from the M1 potentiometer in the SUMMING AMPLIFIER. The amplitude of the sweep waveform is determined by the gain of VARIABLE GAIN AMPLIFIER IC5, which is controlled by the operator selected SYMMETRICAL SWEEP WIDTH resistance. In this way the center frequency is set by the position of the M1 potentiometer and the excursion by the SYMMETRICAL SWEEP WIDTH control.

5-8. EXTERNAL SWEEP MODE. In the EXTernal sweep mode the tuning supply regulator input command is taken directly from the rear panel EXTERNAL SWEEP INPUT connector as shown in Figure 5-7. The operator may introduce signals in the range of 0 to +10 volts causing corresponding RF frequencies over the range of the RF UNIT. Simultaneously the amplifier chain, which duplicates the tuning supply input, applies the external sweep signal to the frequency marker circuit so that M1 and M2 markers may be generated.

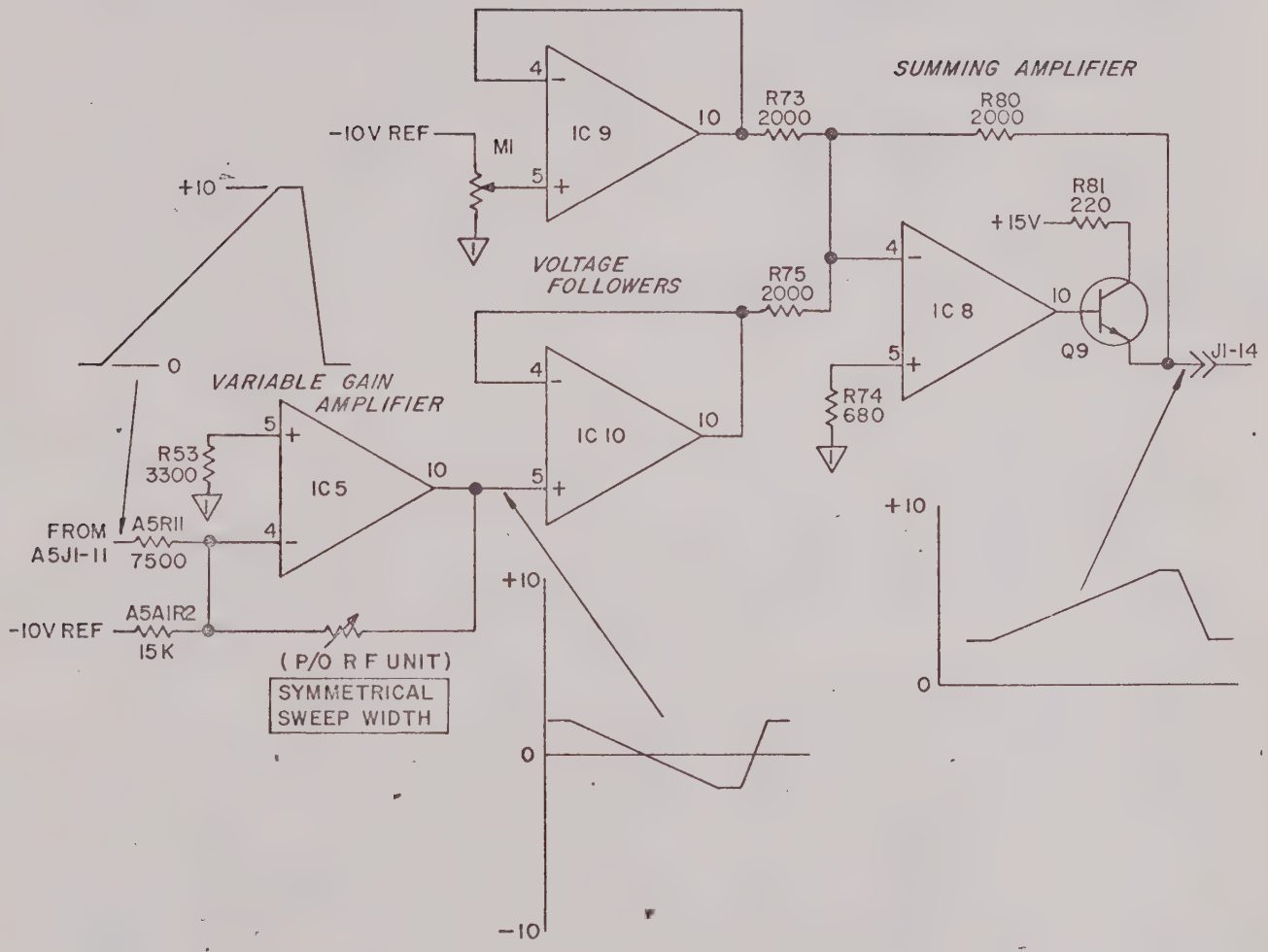
5-9. CW MODE. In the CW mode, depicted in Fig. 5-8, DC output from the M1 potentiometer is applied by IC9 and IC8, and applied to the tuning supply input, setting RF frequency. As an added feature, any DC applied to the EXTERNAL SWEEP INPUT connector from -10 volts to +10 volts adds a linearly analogous frequency shift to the M1 setting.



NOTE: REFER TO FIG. 8-3 FOR COMPLETE SCHEMATIC

FIG 5-5

SWEEP AMPLIFIER
BLOCK DIAGRAM
F1-F2 AND M1-M2 MODES
MODEL 230A

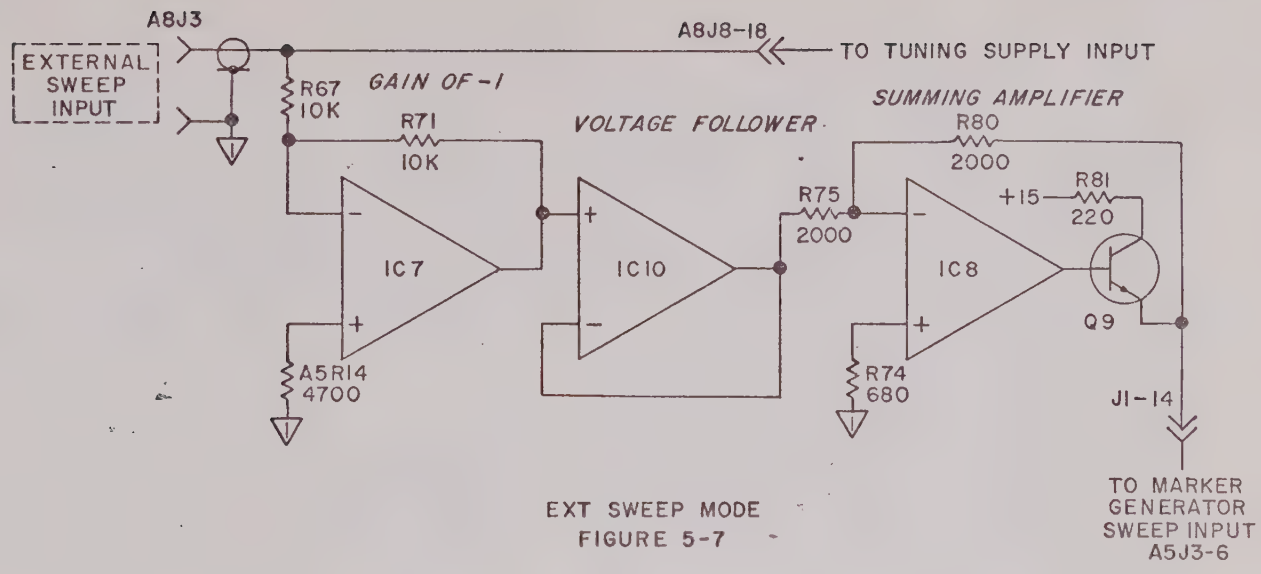


NOTE: REFER TO FIG. 8-3 FOR COMPLETE SCHEMATIC

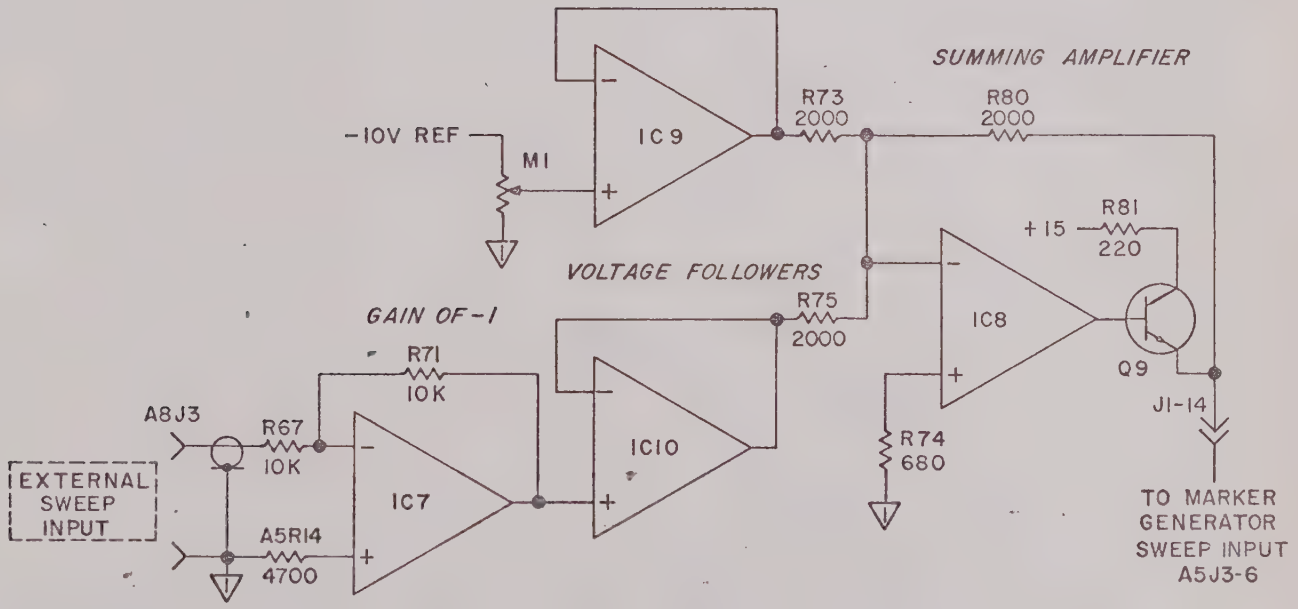
FIG. 5-6

SWEEP AMPLIFIER
BLOCK DIAGRAM
SYMMETRICAL SWEEP MODE

MODEL 230A



EXT SWEEP MODE
FIGURE 5-7



CW MI SWEEP MODE
FIGURE 5-8

FIG. 5-7 & 5-8
SWEEP AMPLIFIER
BLOCK DIAGRAM
EXT & CW MI SWEEP MODE
MODEL 230A

5-10. PROPORTIONAL OUTPUT. The rear panel PROPORTIONAL OUTPUT operates in every SWEEP FUNCTION mode at its 10 volt per band scale factor. As seen in Fig. 5-9, the PROPORTIONAL SWEEP AMPLIFIER SIMPLIFIED SCHEMATIC DIAGRAM, the tuning voltage (input to the TUNING SUPPLY REGULATOR) developed in the mainframe is directly available when the PROPORTIONAL selector is set to 10 v/BAND.

The higher scale factor of 40 v/OCTAVE is obtained from the feedback amplifier consisting of IC6 and Q9. The SWEEP AMPLIFIERS output is applied via R60 and R59 to the non-inverting input of the feedback amplifier (because Q8 inverts, this is pin 4 of IC6). Gain is determined by the values of A7R7 in the RF UNIT and R58. For a one octave RF unit the gain is +4 so that proportional output will be zero at the low end, and +40 volts at the high end of a one octave band e.g. 2 to 4 GHz.

5-11. FREQUENCY MARKER. Each marker is generated by comparing a DC voltage with a sweeping voltage. As the sweep voltage amplitude passes through the value equal to the DC voltage, a marker waveform is generated. The DC voltage is obtained from a front panel marker frequency control potentiometer, whose setting selects voltage amplitude corresponding to its indicator position on the frequency scale.

Figure 5-10 shows the comparison of DC and sweep voltages via equal input resistors to a DIFFERENCE AMPLIFIER. Its output is a greatly amplified version of the zero crossing resulting from the sweep input passing through equality with the DC. The DIFFERENCE amplifier's direct output is compared with the inverted version in an "AND" GATE, which selects the more positive of its inputs, forming a triangle. The apex of this triangle occurs at the value of sweep signal equal to the DC from the marker potentiometer. The outputs of both marker channels are combined in an "OR" GATE, attenuated in the front panel MARKER AMPLITUDE control, and presented both as VIDEO MARKER OUTPUT and as RF amplitude dips if the RF MARKER switch is selected ON.

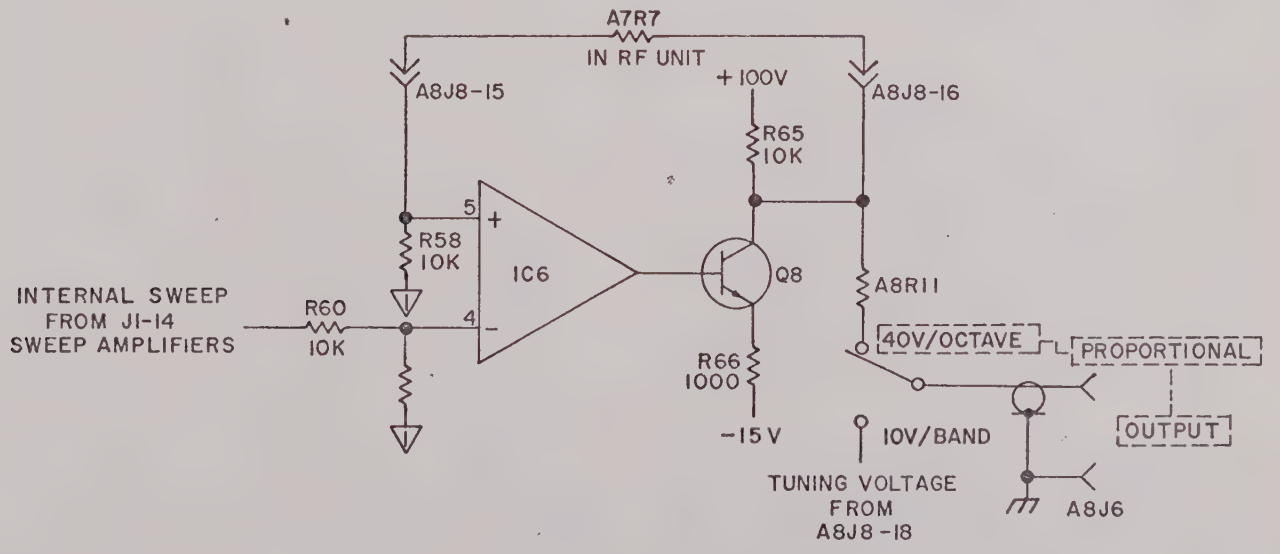


FIGURE 5-9

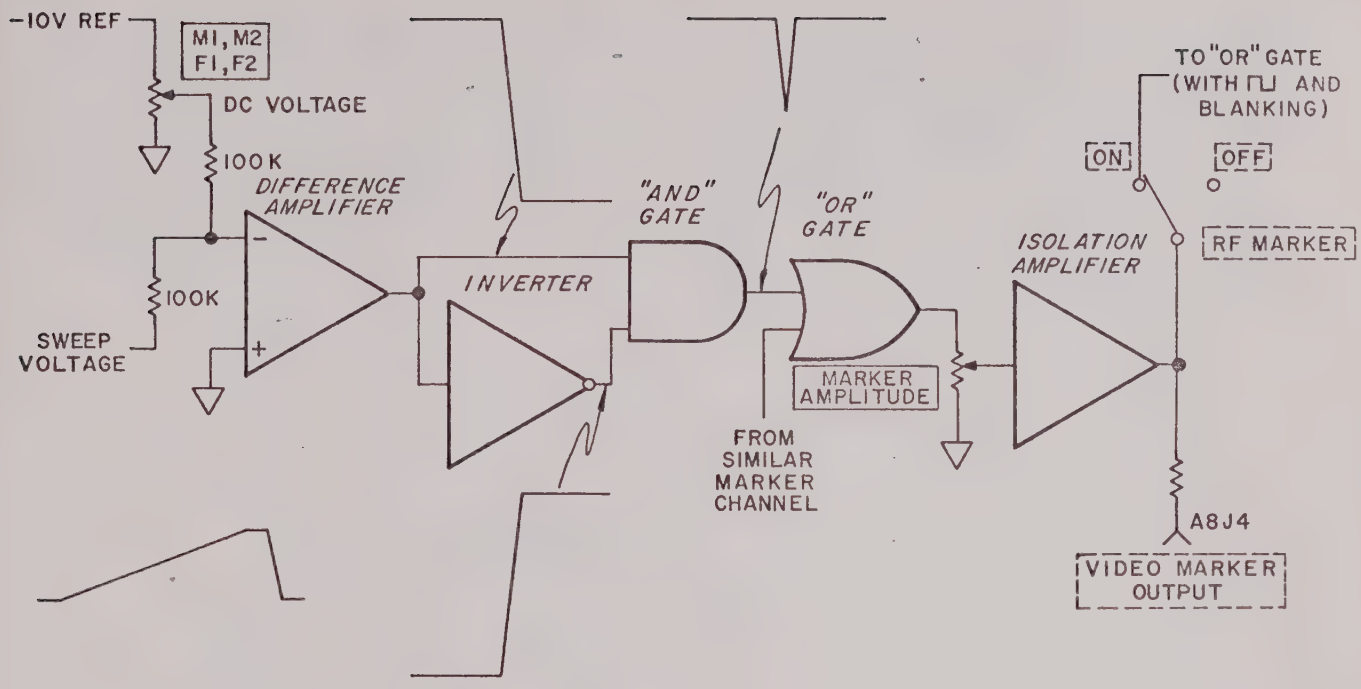


FIGURE 5-10

5-12. SQUARE WAVE GENERATOR. Internal square wave amplitude modulation is provided by the circuit of Fig. 5-11. Q8 and Q9 form an emitter coupled free running multivibrator when 1 KHz switch A8S3 is in its ON position. When Q9 goes into saturation it cuts off Q8 by capacitively driving Q8 emitter to a low potential, while simultaneously applying a high potential to its base coupling diode. In about 500 microseconds capacitor C6 discharges sufficiently that Q8 begins to conduct. In doing so Q8 now capacitively couples a reduced emitter potential to Q9, which conducts less, reducing its collector voltage driving the base of Q8 more negative, regenerating the conduction of Q8 and the cutting off of Q9. Now it is Q9's emitter which has been driven to a low potential which maintains Q9 cut off. After about 500 microseconds capacitor C6 charges sufficiently to allow Q9 to conduct once more. Regenerative action quickly saturates Q9, cutting off Q8, and the cycle continues.

Frequency may be controlled by the front panel 1 KHz ⊓⊔ screwdriver adjustment if desired.

The square wave output is combined with blanking signal from the SAWTOOTH OSCILLATOR and with RF markers to modulate. RF amplitude via the RF UNIT's LEVELER section.

5-13. POWER SUPPLIES. When primary power is applied to the 230A SWEEP OSCILLATOR the PUSH ON switch is illuminated and power transformer R1 energized. As shown in Fig. 6-17 POWER SUPPLIES schematic diagram each of the six secondary windings of T1 has a bridge rectifier and capacitive filter, located on assembly A4. Thus six unregulated DC voltages are produced, from which all required functions are powered.

5-14. ±15 AND -10 VOLT SUPPLIES. Each regulated supply consists of a source of DC voltage, a series control transistor, and an amplifier which compares the regulated output with a voltage reference. In Fig. 5-12 the +15 colt supply uses a zener diode voltage reference A3CR3. The +15 volt supply serves as the reference voltage for the two negative supplies. The -10 volt supply uses the -15 volt as its source of DC voltage.

5-15. BIAS SUPPLY. Power for the RF oscillator, in the RF UNIT, is provided by the BIAS SUPPLY. Its unregulated DC voltage and a series pass transistor A5Q5, driver A3Q7 and current limiter A3Q6 are located in the 230A mainframe. The RF UNIT instruction manual details how these are arranged to meet each RF oscillator's requirements in Section 5-2.

5-16. TUNING SUPPLY. The unregulated DC for YIG tuned RF oscillators, and a 200 Volt unregulated DC supply are provided in the 230A mainframe. In addition a series pass transistor A5Q2 with current limiter A5Q3 in the mainframe are used as part of the tuning supply regulator. The RF UNIT Instruction Manual details how these are arranged to meet each RF oscillator's requirements in Section 5-3.

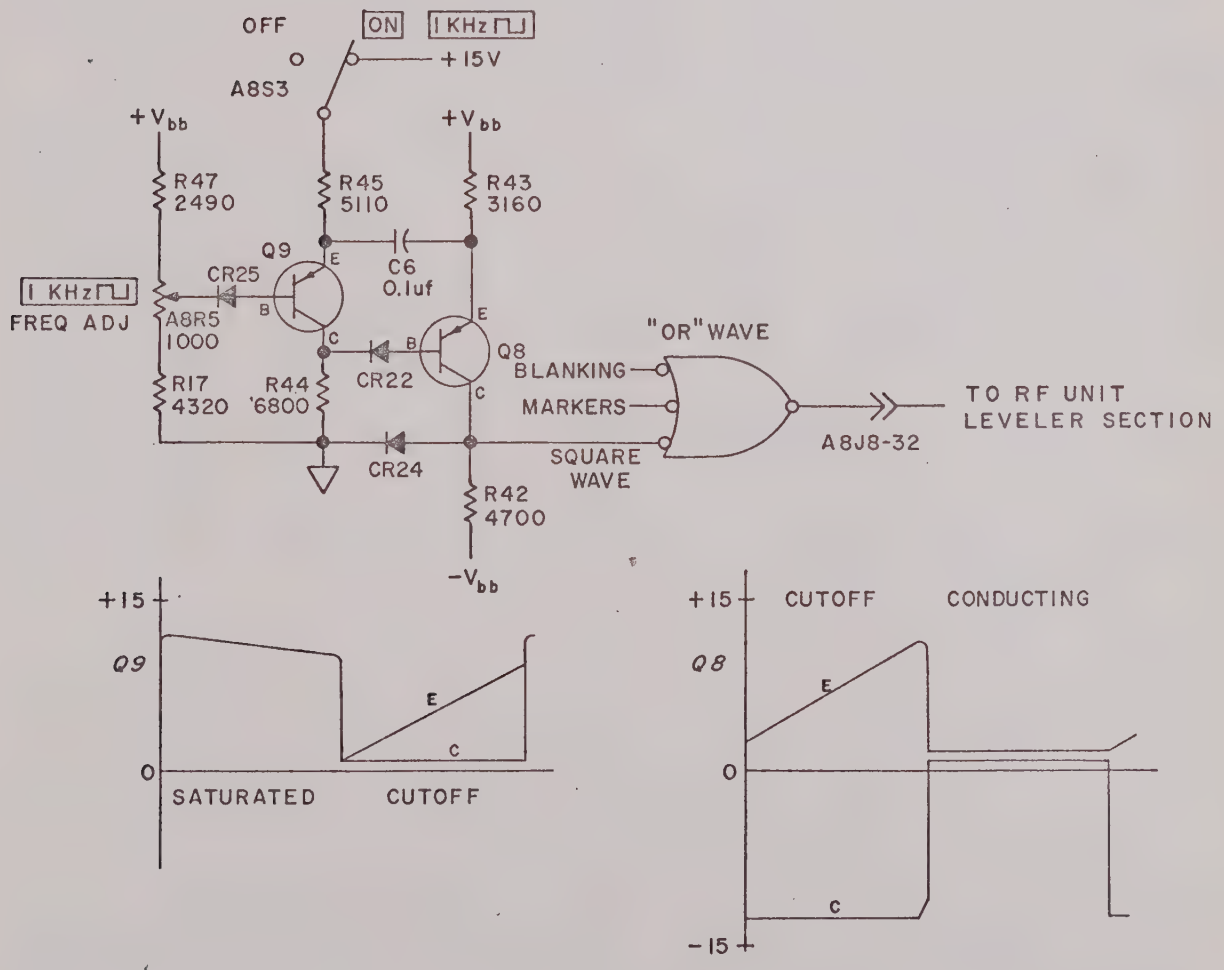


FIGURE 5-11

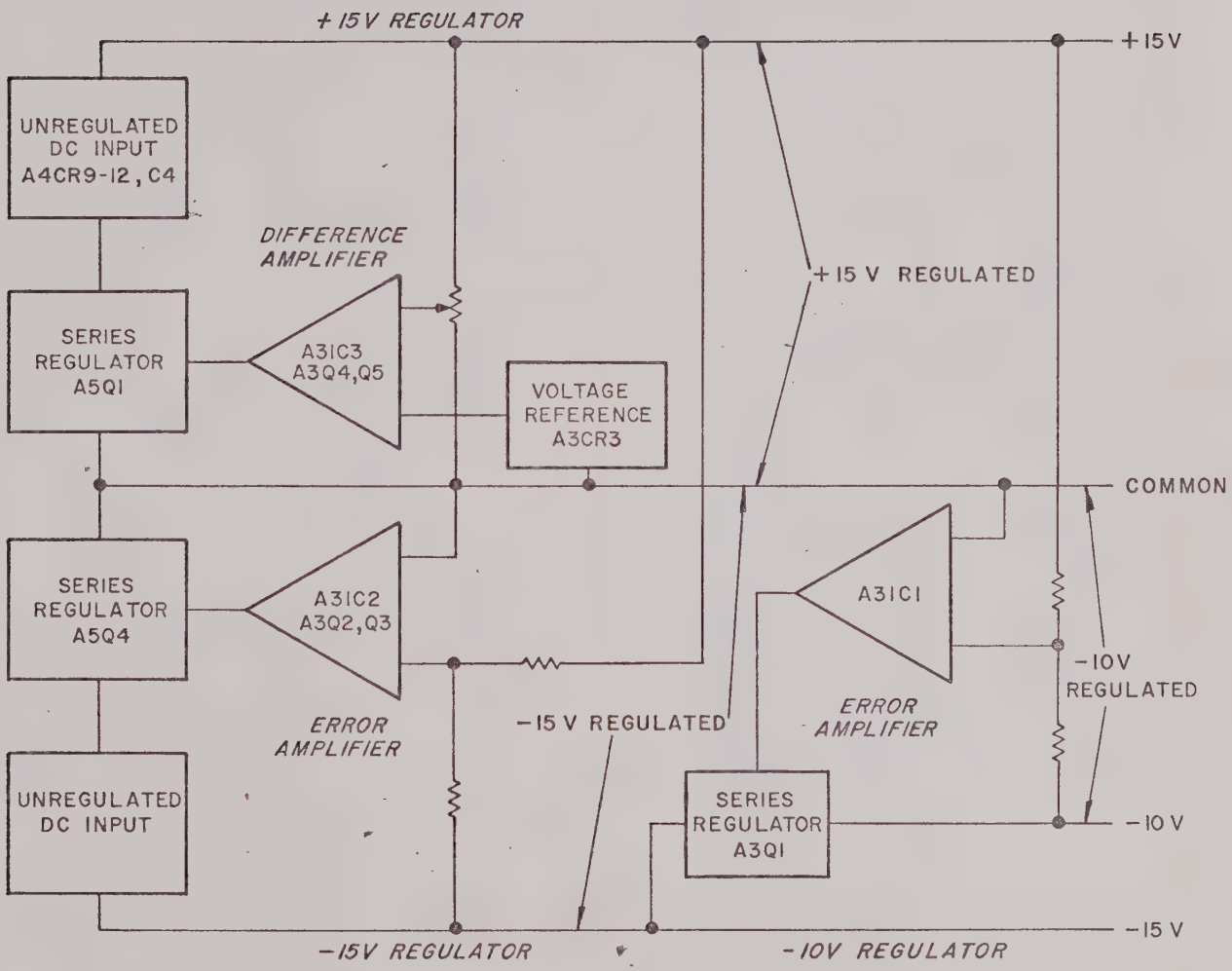


FIG. 5-12

±15 VOLT AND -10 VOLT SUPPLIES

MODEL 230A

SECTION 6-0

MAINTENANCE

6-1 TEST EQUIPMENT REQUIRED. Basic equipment required to conduct performance tests is listed in Table 6-1 and equipment required to perform calibration in Table 6-2. Any model meeting at least these minimum requirements may be used.

Measurement of power supply outputs should be made with the precision DC voltmeter; other potentials with the calibrated oscilloscope or a 20,000 Ω per volt meter.

6-2 PERFORMANCE TESTS. The following tests are used to check the instrument against its specifications and are suggested for incoming inspection, periodic maintenance and after servicing.

6-3 FREQUENCY ACCURACY

(a) Connect equipment per Figure 6-1

(b) Set the SWEEP OSCILLATOR controls as follows:

TRIGGER	LINE
MARKER AMPLITUDE	clockwise
SWEEP FUNCTION	F1-F2
SWEEP TIME (SEC)	.1
F1	low limit
F2	High limit
1 kHz	off
SWEEP RESPONSE TIME	NORMAL
RF MARKERS	ON

If the RF UNIT has Option-1 (internal leveling) set:

LEVELER MODE	INT
RF LEVEL	adjust counter-clockwise just enough to obtain leveling across the entire band

If the RF UNIT does not have Option -1 (internal leveling) set:

LEVELER MODE	OFF
RF LEVEL	maximum clockwise

(c) Set the M1 and M2 indicators at the frequencies to be checked. Adjust the MARKER AMPLITUDE as desired. Tune the frequency meter to make its dip coincident with each marker dip.

(d) The marker frequency indicator and the frequency meter indication should agree within the Frequency Accuracy specification of the RF UNIT.

6-4 POWER OUTPUT, UNLEVELED.

(a) Connect the power meter to the RF OUTPUT through a pad, with no intervening cable.

(b) Set the SWEEP OSCILLATOR controls as follows:

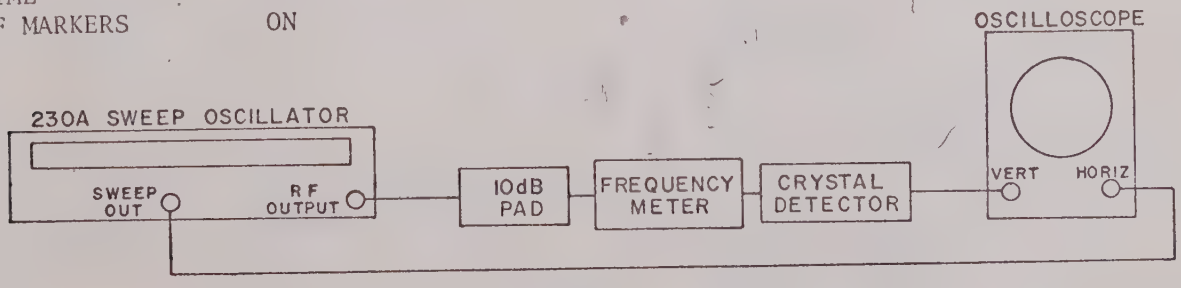


FIGURE 6-1

* RF units featuring internal leveling, Option - 1, have a slightly lower specification than those which do not include internal leveling.

TABLE 6-1

TEST EQUIPMENT

FOR PERFORMANCE TESTING

Title	Requirements	Suggested Manufacturer and Model No.
Variable Transformer	at least 105 to 125 VAC 1 AMP	Superior Electric Co. 3PF116
AC Voltmeter	at least 105-125 VAC ±1% 48-420 Hz	Weston 433
Oscilloscope	Vertical: DC to at least 300 kHz 10 mV/cm ±3% calibration 1 Megohm min. input resistance Horizontal: DC to 300 kHz 0.3 to 1 Volt/cm sensitivity sweep time calibration ±3%	Tektronix 516A with 2A63 Differential Ampl and 2B67 Time Base
Frequency Meter, Reaction Type		
200-500 MHz	±0.1% accuracy	Narda 804
500-1000 MHz	±0.1% accuracy	Narda 805
1-2 GHz	±0.1% accuracy	General Microwave N607
1-4 GHz	±0.1% accuracy	General Microwave N604
4-8.2 GHz	±0.1% accuracy	General Microwave N608A
8.2-12.4 GHz	±0.1% accuracy	HP X532B with two coaxial to waveguide adaptors
12.4-18 GHz	±0.1% accuracy	HP P532A with two coaxial to waveguide adaptors
10 dB Attenuator Pad	Calibrated within ±0.1dB VSWR 1.3 max	Weinschel Model 2 or 2A
RF Power Meter with Thermister Mount	±0.3 dB	HP 432 A with
0.2 to 8.2 GHz		HP 478A
8.2 to12.4 GHz		HP X486A with coaxial to waveguide adaptor
12.4 to 18 GHz		HP P486A with coaxial to waveguide adaptor
Directional Coupler	10 dB coupling factor	
30 to 1000 MHz	20 dB directivity	Anzac DCG10
500 to 1000 MHz		Esca 70070-209
1-2 GHz		Narda 3042-10
2-4 GHz		Narda 3043-10
4-8 GHz		Narda 3044-10
8-12.4 GHz		Narda 3045C-10
12.4-18 GHz		Narda 1069-10
Wave Form Generator	±10 Volt, less than 1 μ sec. rise time 10 to 1000 Hz	Exact Electronics 100
Ohmmeter	DC continuity	Simpson 261

TABLE 6-2

TEST EQUIPMENT FOR CALIBRATION

Title	Requirements	Suggested Manufacturer and Model No.
Precision DC Voltmeter	±0.1% accuracy 400 K minimum resistance 1 millivolt sensitivity	Fluke 891 A

SWEEP FUNCTION	CW ML
1 kHz	off
RF LEVEL	fully clockwise
LEVELER MODE	OFF

(c) Tune the M1 control across the band and note the minimum output power.

(d) The minimum power should be at least the Min. Power Output (mW) specified* for the RF UNIT. Power meter and pad calibration factors should be taken into account.

6-5 POWER VARIATION, LEVELED

6-6 INTERNAL LEVELING

(a) Connect the Power Meter to the RF OUTPUT through a pad, with no intervening cable.

(b) Set the SWEEP OSCILLATOR controls as follows:

MARKER AMPLITUDE	maximum counterclockwise
SWEEP FUNCTION	F1-F2
SWEEP TIME	MAN
F1	low end of band
F2	High end of band
1 kHz ⊓⊔	off
LEVELER MODE	INT

Adjust the SWEEP TIME manual VARIABLE knob through its entire rotation, and adjust the RF LEVER control counterclockwise just enough to obtain leveling across the band and the UNLEVELED indicator remains extinguished.

(c) Note the maximum and minimum Power Meter indication limits in dB as the VARIABLE knob is slowly adjusted through its entire rotation.

(d) The total power variation observed should be less than the total variation specified for the RF UNIT The variation due to the pad should be taken into account.

6-7 EXTERNAL CRYSTAL LEVELING

(a) Connect the equipment per Figure 6-2

(b) Set the SWEEP OSCILLATOR controls as follows:

TRIGGER	LINE
SWEEP FUNCTION	F1-F2
SWEEP TIME (SEC)	.01
F1	low end of band
F2	high end of band
1kHz ⊓⊔	off
SWEEP RESPONSE	NORMAL
LEVELER MODE	XTAL EXT

Adjust the RF LEVEL control over its range. If the oscilloscope display shows oscillation of the leveling loop, adjust the GAIN control to stop the oscillation. Set the RF LEVEL control counterclockwise just enough to obtain leveling across the band and the UNLEVELED indicator remains extinguished.

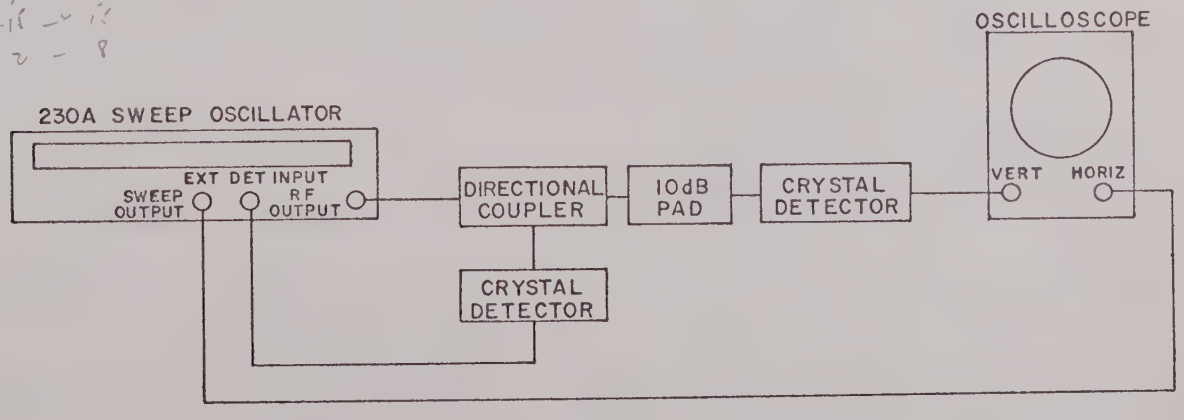


FIGURE 6-2

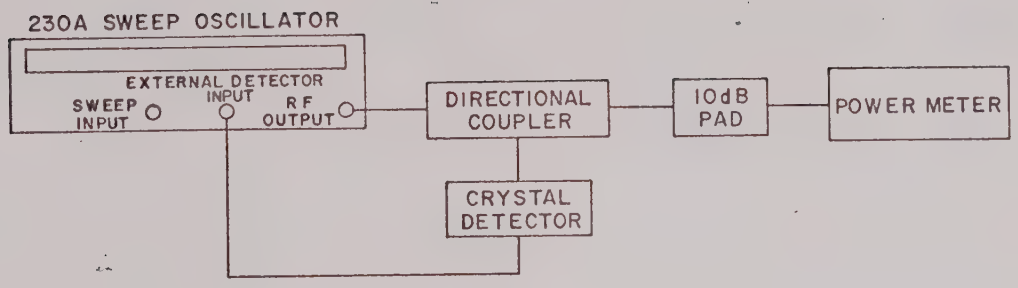


FIGURE 6-3

(c) Replace the oscilloscope and crystal detector with an RF Power Meter as shown in Figure 6-3. Set the SWEEP TIME control to MAN.

Note the maximum and minimum Power Meter indication limits in dB as the VARIABLE knob is adjusted through its entire rotation.

(d) The total power variation observed should be less than the total variation specified. The variation due to the directional coupler and associated external leveling crystal detector must be taken into account, as well as variation due to the pad.

6-8. POWER METER LEVELING.

(a) Connect the equipment per Fig. 6-2 except that a Power Meter having DC output e.g. a recorder output is substituted for the crystal detector which drives the EXT DETECTOR INPUT.

(b) Set the SWEEP OSCILLATOR controls as follows:

MARKER AMPLITUDE	maximum counterclockwise
SWEEP FUNCTION	F1-F2
SWEEP TIME	MAN
F1	low end of band
F2	high end of band
1 kHz ⊓⊔	off
LEVELER MODE	PWR MTR + or - to conform with the Power Meter DC output polarity.

Adjust the manual VARIABLE knob through its entire rotation, and adjust the RF LEVEL control counterclockwise just enough to obtain leveling across the band and the UNLEVELED indicator remains extinguished.

(c) Note the maximum and minimum Power Meter indication limits in dB as the VARIABLE knob is slowly adjusted through its rotation.

(d) Maximum variation should be ±0.1 dB.

6-9. SWEEP TRIGGER

6-10. AUTOMATIC

(a) Connect the equipment per Fig. 6-1. The frequency meter may be omitted.

(b) Set the SWEEP OSCILLATOR controls as follows:

TRIGGER	AUTO
SWEEP FUNCTION	F1-F2
SWEEP TIME (SEC)	.1

(c) The sweep should occur on the oscilloscope and the SWEEP ON indicator be illuminated during forward trace.

6-11. LINE TRIGGER

(a) Repeat 6-6-1 (a) except set TRIGGER selector to LINE.

6-12. SINGLE SWEEP. Repeat 6-10 except set TRIGGER selector to its momentary SINGLE SWEEP position. The sweep should occur once each time SINGLE SWEEP is selected. The TRIGGER selector springs

back to its EXT position when released. Do not apply EXTERNAL TRIGGER signals when using SINGLE SWEEP TRIGGER.

6-13. EXTERNAL TRIGGER

(a) Repeat 6-10 (a) except set TRIGGER selector to its EXT position.

(b) Apply any convenient trigger waveform e.g. sine, square, ramp, pulse longer than 1 microsecond to the rear panel EXTERNAL TRIGGER input. Repetition frequencies from 1 to 100 Hz are suggested. Increase amplitude till reliable sweep generation occurs.

(c) Amplitude required should not exceed -10 volts.

6-14. INTERNAL SQUARE WAVE

6-15. UNLEVELED

(a) Connect the equipment per Figure 6-1. The frequency meter and the sweep output cable may be omitted.

(b) Set the SWEEP OSCILLATOR CONTROLS as follows:

1 kHz ⌐⌙	ON
RF LEVEL	fully clockwise
LEVELER MODE	OFF

(c) Using the oscilloscope time base measure square wave rise time, fall time, symmetry and period.

(d) Rise time and fall time should each be 10 microseconds maximum; symmetry within 60:40; period adjustable from less than 950 to more than 1050 microseconds.

6-16. LEVELED

(a) If the RF Unit has Option -1, set controls as follows:

LEVELER MODE	INT
1 kHz ⌐⌙	ON
RF LEVEL	just counterclockwise enough to extinguish the UNLEVELED indicator

(b) If not, connect the equipment per Figure 6-2, controls as above except

LEVELER MODE XTAL EXT

(c) Using the oscilloscope time base measure rise time, fall time and symmetry.

(d) Rise and fall time should each be 10 microseconds maximum; symmetry within 60:40.

6-17. EXTERNAL AM

(a) Set up the equipment as follows:

1 kHz ⌐⌙	off
RF LEVEL	maximum counterclockwise
LEVELER MODE	off

(b) Apply the output of a square wave generator to the rear panel AM INPUT. Adjust amplitude so that further increase does not increase RF amplitude.

(c) Rise and fall time should not exceed 1 microsecond, maximum amplitude should not exceed +10 volts.

(d) Set up as in 6-16 except

1 kHz ⌐⌙	off
RF LEVEL	maximum counterclockwise

Repeat 6-17 (b)

(e) Rise and fall time should not exceed 10 microseconds.

6-18. SYMMETRICAL SWEEP WIDTH ACCURACY

(a) Connect the equipment per Fig. 6-1.

(b) Set the SWEEP OSCILLATOR controls as follows:

TRIGGER	LINE
SWEEP FUNCTION	SYM M1
SWEEP TIME (SEC)	.1
M1	Center of Band
RF LEVEL	Maximum clockwise
LEVELER MODE	OFF
SWEEP RESPONSE TIME	NORMAL

(c) At each setting of the SYMMETRICAL SWEEP WIDTH control to be checked tune the frequency meter to the high frequency end of the display and to the low end.

(d) The difference between the frequency meter readings should be within ±10% of the calibrated setting of the SYMMETRICAL SWEEP WIDTH control.

6-19. RESIDUAL FM

(a) Connect the equipment per Figure 6-1.

(b) Set the SWEEP OSCILLATOR controls per 6-18 (b) and place the SYMMETRICAL SWEEP WIDTH control maximum counter-clockwise.

(c) Calibrate the frequency meter as a slope discriminator as follows: Tune the frequency meter so that its dip is centered in the display as illustrated in Fig. 6-4. Place a straight edge on the oscilloscope display and measure the maximum slope of the frequency meter dip. Divide the vertical measurement to obtain the discriminator constant in millivolts/kHz.

(d) Place the SWEEP FUNCTION selector in CW M1. Increase the oscilloscope vertical sensitivity and tune the frequency meter for maximum peak to peak vertical amplitude. The oscilloscope time base may be used if desired. Record the peak to peak amplitude. Divide by the discriminator constant to obtain kHz peak to peak. Divide again by 2 to obtain peak residual FM. This should not exceed the specification for the RF Unit used.

6-20. BLANKING OUTPUT

(a) Connect the rear panel BLANKING OUTPUT to the oscilloscope vertical input.

(b) Set the sweep OSCILLATOR controls as follows:

TRIGGER	LINE
SWEEP FUNCTION	F1-F2
SWEEP TIME	0.1

(c) Output should be at least -5 volts (coincident with sweep retrace).

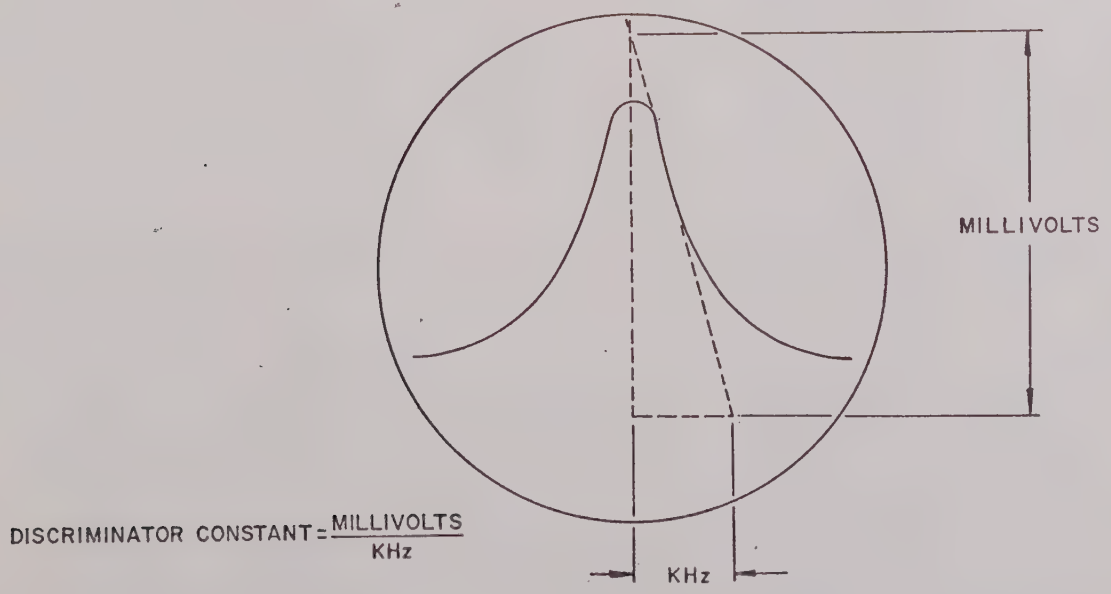


FIGURE 6-4

6-21. MARKER VIDEO OUTPUT

(a) Connect the rear panel MARKER VIDEO OUTPUT to the oscilloscope vertical input.

(b) Set the SWEEP OSCILLATOR controls as follows:

MARKER AMPLITUDE	fully clockwise
TRIGGER	LINE
SWEEP FUNCTION	F1-F2
F1	low end of band
F2	high end of band
M1 and M2	within band
SWEEP TIME (SEC)	.1

(c) Output should be at least -5 volts

6-22. PEN LIFT

(a) Connect an ohmmeter to the rear panel PEN LIFT TERMINALS.

(b) Set the SWEEP OSCILLATOR controls as follows:

TRIGGER	LINE
SWEEP FUNCTION	F1-F2
SWEEP TIME (SEC)	10

(c) Ohmmeter should indicate continuity during forward trace; open during retrace.

6-23. PROPORTIONAL SWEEP AMPLITUDE

(a) Connect the PROPORTIONAL OUTPUT to the oscilloscope vertical input.

(b) Set the SWEEP OSCILLATOR controls as follows:

TRIGGER	LINE
SWEEP FUNCTION	F1-F2
SWEEP TIME (SEC)	0.1
F1	lower limit
F2	upper limit
PROPORTIONAL	10V/BAND

(c) The PROPORTIONAL OUTPUT should start at +0.25 ±0.25 volts and finish at +9.75 ±0.25 volts.

(d) Reset the rear panel PROPORTIONAL control to 40 V/OCTAVE. The output should now start at +1 ±1 volt and finish at +40 ±3 volts per octave of the RF UNIT frequency coverage.

6-24. CALIBRATION PROCEDURES

6-25. REFERENCE POWER SUPPLIES

(a) Remove the RF UNIT. Connect the precision voltmeter to A5J4-1(1), -10 Volt supply, and to A5J4-3(+), its return.

(b) Adjust trimmer A3R16 until the voltmeter indicates 10.000 ± 0.010 volts DC.

(c) Confirm that the -15 volt regulated supply is accurate by measuring between A5J4-6(-) and A5J4-3(+). Confirm that the +15V regulated supply is accurate by measuring between A5J4-24(+) and A5J4-3(-). These should be 15.000 volts within ± 0.020 volts.

6-26. DIAL MECHANISM CALIBRATION

(a) Set all four indicators M1, M2, F1 and F2 at the nominal low end of the frequency scale as illustrated in Figure 6-6. Place the SWEEP FUNCTION selector in F1-F2.

(b) Connect the voltmeter from A5J1-4(+) to A8TP2(-). [See Fig. 6-5 Alignment Trimmer (A6) Component Locations for test point identification]. Adjust A6R6 to obtain a reading of 0.328 volts ±0.005 volts.

(c) Connect the voltmeter from A5J1-4(+) to A8TP3(-). Adjust A6R3 to obtain 0.328 ± 0.005 volts.

(d) Place the SWEEP FUNCTION selector in M1-M2.

(e) Connect the voltmeter from A5J1-4(+) to A8TP1(-). Adjust A6R7 to obtain 0.328 ± 0.005 volts.

(f) Connect the voltmeter from A5J1-4(+) to A8TP4(-). Adjust A6R2 to obtain 0.328 ± 0.005 volts.

(g) Set all four indicators M1,M2,F1 and F2 at the nominal high end of the frequency scale per Fig. 6-7.

(h) Connect the voltmeter between A6TP3(-) and A8TP1(+). Adjust A6R3 to obtain 0.328 ± 0.005 volts.

(i) Connect the voltmeter between A6TP3(-) and A8TP4(+). Adjust A6R1 to obtain 0.328 ± 0.005 volts.

(j) Place the SWEEP FUNCTION selector in F1-F2.

(k) Connect the voltmeter between A6TP2(-) and A8TP2(+). Adjust A6R5 to obtain a reading of 0.328 ± 0.005 volts.

(l) Connect the voltmeter between A6TP2(-) and A8TP3(+). Adjust A6R4 to obtain a reading of 0.328 ± 0.005 volts.

6-27. WAVEFORM GENERATOR ALIGNMENT

(a) Connect a temporary jumper from A5J1-11 to J1-4.

(b) Set the SWEEP OSCILLATOR controls as follows:

TRIGGER	EXT
SWEEP FUNCTION	F1-F2
SWEEP TIME (SEC)	.1 — .01
F1	low end of band

(c) Observe the voltage between J1-8 and J1-4 (return). Adjust R69 to set the voltage to -10.000 ± 0.002 volts.

(d) Observe the voltage between J1-5 and J1-4 (return). Adjust R55 to set this voltage to 0 ± 0.002 volts.

(e) Connect temporary jumpers from A5J1-12 to J1-4 and J1-13 to J1-4. The jumper of (a) above is no longer required.

(f) Observe the voltage between J1-14 and J1-4 (return). Adjust R77 to set this voltage to 0 ± 0.002 volts.

(g) Remove the temporary jumpers.

6-28. MARKER ALIGNMENT.
INSTALL R.F. UNIT — J.F. (4/2/14)

(a) Connect the SWEEP OUT to the oscilloscope horizontal input: MARKER VIDEO OUTPUT to the oscilloscope vertical input.

(b) Set the SWEEP OSCILLATOR controls as follows:

MARKER AMPLITUDE	clockwise
SWEEP FUNCTION	F1-F2
SWEEP TIME (SEC)	.1
TRIGGER	Auto
M1	Exactly mid-band
F2	One scale division higher than M1 setting
F1	One scale division lower than M1 setting.
M2	Outside of setting of F1 and F2 away from mid-band.

(c) Adjust A2R1 so that M1 marker appears at the center of the oscilloscope display.

(d) Set M1 outside of settings of F1 and F2 away from mid-band.

Set M2 at mid-band exactly.

Adjust A2R2 so that M2 marker appears at the center of the oscilloscope display.

6-29. RF UNIT CALIBRATION. Calibration procedures for the RF UNIT appear in its Instruction Manual.

6-30. SERVICING. Removing the top cover of the mainframe provides access to its interior. The plug-in cards may then be readily exchanged or checked. Their circuit functions are printed on the underside of the top cover to facilitate fault location.

Removing top and bottom covers enables one to operate the equipment normally with access to test points. In addition the rear panel access plate makes possible measurement of potentials on the RF UNIT 36 pin connector A8J8.

Removal of the top and bottom covers of the RF UNIT extends access to its interior also, with the equipment in normal operation.

6-31. TROUBLESHOOTING PROCEDURE. When a unit is found to be operating improperly compare the symptoms with those listed in Table 6-3. Isolate the difficulty to the most probable sub-system and proceed logically to identify the faulty component or connection. Compare operating voltages with th normal values given in Tables 6-6 thru 6-9.

6-32. IDENTIFICATION OF SUBASSEMBLIES AND COMPONENTS. All subassemblies are identified by reference designations explained in Section 7. Refer to Component Layout of Figures 8-1 thru 8-6 to identify components within these subassemblies.

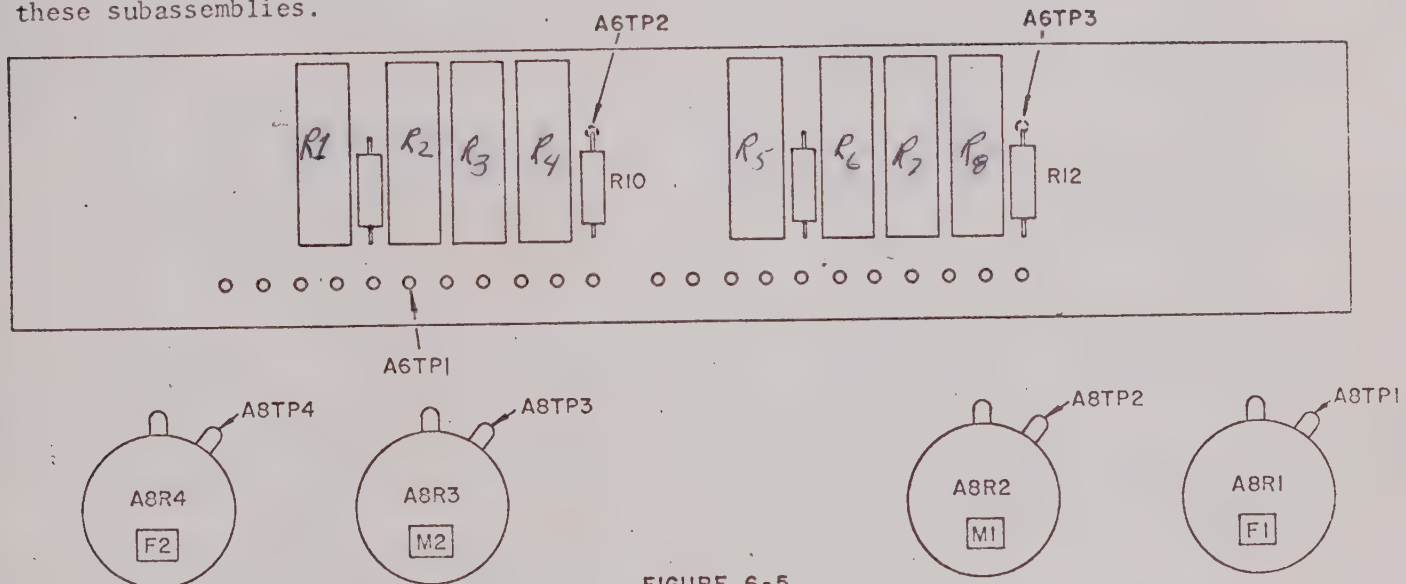


FIGURE 6-5

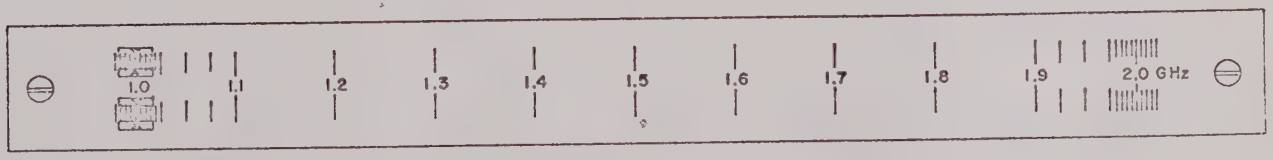


FIGURE 6-6

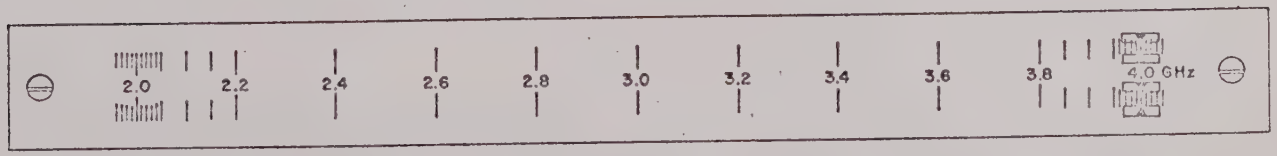


FIGURE 6-7

6-33. MAJOR REPAIR - Preliminary Calibration.

The preliminary calibration procedure described below should be followed when repairs have been made on main chassis wired components or sub-assemblies such as the power transformer, harness, or dial mechanism.

(1) AC LINE POWER.

a. Prepare the mainframe as follows:

1) Remove RF UNIT plug-in.
2) Remove plug-in P.C. boards A1, A2, A3 and A4.
3) Set 115/230V switch to 115.
4) Check fuse rating 3A.

b. Turn unit on and check that push on lamp lights.

(2) Turn unit off and check that:

a. Open circuit exists between A5J1-4 and chassis ground.

b. Open circuits exist between pin A8J10-1 and chassis ground and pin A8J10-2 and chassis ground.

(3) The calibration procedure should be performed with the RF UNIT removed. Under this circumstance, a jumper is required to be connected between A5J1-4 and chassis ground. Due to the close spacing between pins, a small insulated clip (such as Test Clip mfg. by E-Z Hook) should be used to connect to A5J1-4. Alternatively, a wire can be tack soldered to A5J1-4 for making this connection.

(4) Install P.C. boards A3 and A4 and check the voltages in accordance with Fig. 6-8, and then install the A1 and A2 P.C. boards.

(5) DIAL MECHANISM.

a. Check the four controls (M1 M2 F1 F2) for smooth travel and equal tension.

b. Rotate each control from one mechanical limit to the other and note that the overtravel of the pointer beyond the last gradation on the scale on each end of the scale is equal.

(6) Go to 6-25 REFERENCE POWER SUPPLIES.

(7) Go to 6-26 DIAL MECHANISM CALIBRATION.

(8) Go to 6-27 WAVEFORM GENERATOR ALIGNMENT.

(9) Go to 6-28 MARKER ALIGNMENT.

(10) SQUARE WAVE CHECK.

a. Set the SWEEP OSCILLATOR CONTROLS as follows:

1 KHz ON

b. Connect the oscilloscope vertical input to A5J3-21 and the ground terminal of the oscilloscope to chassis ground.

c. Using the oscilloscope time base, measure square wave rise time, fall time, symmetry and period.

d. Rise time and fall time should each be 10 microseconds maximum; symmetry within 60:40; period adjustable from less than 950 to more than 1050 microseconds.

(11) Go to 6-13 EXTERNAL TRIGGER except disregard RF UNIT plug-in and its connection to vertical input to oscilloscope.

(12) Go to 6-20 BLANKING.

(13) Go to 6-21 MARKER VIDEO OUTPUT.

(14) Go to 6-22 PEN LIFT.

(15) a. Connect a 69.8 K ohm 1% resistor between A5J2-10 and A5J2-11.

b. Go to 6-23.

(16) Go to 6-13.

NOTE: Remove jumper before plugging in RF UNIT.

A 3 TP7 8 5 6 4 3 2 1

Supply	Pin Connections	DC Voltage Volts	Tolerance Volts
+15	A3 TP7 A5J4-2 and Gnd.	+15	± 3
-15	A3 TP4 A5J4-4 and Gnd.	-15	± 3
-10	A3 TP1 A5J4-1 and Gnd.	-10	± 3
Yig	A5J5-24 (pos) A5J5-16 (neg)	30	± 6
Bias	A5J5-20 (pos) A5J5-17 (neg)	40	± 8
200V	A5J5-8 (pos) A5J5-2 (NEG)	220V	±20
100V	A5J5-9 (pos) A5J5-5 (neg)	110V	±10

Figure 6-8

POWER SUPPLY VOLTAGES

TABLE 6-3

TROUBLESHOOTING SYMPTOMS

Symptom	Trouble Location	Probable Cause
No lamps illuminate	Primary power circuit	Blown Fuse Defective line cord No power at receptacle Defective on/off switch
No sweep	±15 volt supply A3 Card	Defective ±15V Regulator Shorted supply output
	Control settings	TRIGGER selector in EXT with no trigger signal applied SWEEP FUNCTION in CW or EXT SWEEP TIME in MAN
	A1 Card Wave Form Generator	Defective sweep oscillator
No marker	Control settings	MARKER AMPLITUDE set too low RF MARKER switch turned OFF
	A2 Card Marker Generator	Defective
No square wave modulation	Generator A2 Card	Defective 1 KHz ON switch Defective
Frequency Calibration off	-10V Reference Supply A3 Card	Reference Power Supplies Alignment
	Marker Generator A2 Card	Marker Alignment
	RF Unit	See RF UNIT Instruction Manual
High residual FM in CW mode	Power supply regulator A3 Card	Defective component
	RF UNIT	See RF UNIT Instruction Manual
No RF Output No Control of RF Output No Leveling	RF UNIT	See RF UNIT Instruction Manual

TABLE 6-4

TROUBLESHOOTING THE ±15V SUPPLIES

Step	Symptom	Procedure	Indication	Conclusion
1	High Output (and ripple) on +15V Supply			Fault is in +15V Supply
		Measure Voltage from A5J4-15 to J4-16 (return)	less than -½V	A5Q1 shorted
			more than -½V	Proceed to step 2
2		Measure Voltage from R19 to TP5 (return)	less than -2V or positive more than -3V	Defective Q5 or associated Component Proceed to step 3
3		Measure voltage from IC3-4 and IC3-5 to TP-5 (return)	if IC3-5 more positive than -4	Defective IC3
			If IC3-4 more than +6.6 Volt	Defective CR3 or associated component
			If IC3-4 and -5 within 0.1 Volt	CR4 shorted or defective IC3
			If IC3-4 more positive than IC3-5	Defective R12, 15 or 16
4	High Output (and ripple) on -15V Supply	Check +15V Supply	Higher Output (and ripple)	Proceed to step 1
			Normal +15V	Fault is in -15V Supply, proceed to Step 5
5		Measure voltage from A5J4-10 to A5J4-11 (return)	less than +½V	A5Q4 shorted
			more than +½V	proceed to Step 6
6		Measure voltage from TP2 to TP5 (return)	less than +1½V	Defective Q2
			more than +2½V	Proceed to Step 7
7		Measure voltage from IC2-5 to TP-5 (return)	If IC2-5 more negative than -0.1 volt	IC2 defective
			If IC2-5 more positive than +0.1V	Defective R6 or R9
			If IC2-5 less than ±0.1V	Shorted CR2 or Defective IC2

TABLE 6-4 (Cont'd.)

TROUBLESHOOTING THE ±15V SUPPLIES

Step	Symptom	Procedure	Indication	Conclusion
8	No Output from +15V Supply (less than 5 volts)	Measure voltage from A5J4-24 to J4-14 (return)	less than +5V	Defective connection or component on A4 Card unregulated Input to +15V supply or no AC from T1 winding 9-10
			more than +15V	proceed to step 9
9		Measure voltage from J4-16 to J4-17 (return)	more than -½V	Output of supply shorted
			less than -½V	Defective A5Q1 Associated component or correction
10	Low Output from +15V Supply (more than 5 volts)	Check -15V Supply	less than -5V	Defective -15V Supply Proceed to Step 14
			more than -5V (and same magnitude as Output of +15V Supply)	Defective +15V Supply Proceed to Step 11
11		Measure Voltage from A5J4-24 to J4-14 (return)	less than +16V	Low primary line voltage, low AC from T1 winding 9-10, defective component on A4 Card unregulated input to +15V Supply
			more than +16V	Proceed to Step 12
12		Measure Voltage from TP3 to TP5 (return)	less than +5V	Defective CR3 or associated Component
			more than +5½V	Defective IC3 or associated Component
13	No Output or low Output from -15V Supply	Measure Output of +15V Supply	less than +5V	Defective +15V Supply Proceed to Step 8
			more than +5V	Proceed to Step 14
14		Measure Voltage from A5J4-6 to A5J4-9 (return)	less than +16V	Defective connection or component on A4 Card unregulated input to -15V Supply
			more than +16V	Proceed to Step 15

TABLE 6-4 (Cont'd.)

TROUBLESHOOTING THE ±15V SUPPLIES

Step	Symptom	Procedure	Indication	Conclusion
15	No Output or Low Output from -15V Supply (Cont'd.)	Measure voltage from J4-11 to J4-17 (return)	more than ½V	Output of Supply Shorted
			less than ½V	Proceed to Step 16
16		Measure voltage from A5J4-10 to J4-11 (return)	more than +½V	Defective A5Q4 Associated Component or connection
			less than +½V	Proceed to Step 17
17		Measure voltage from TP2 to TP5 (return)	more than +1½V	Defective Q2 or connection
			less than +1V	Proceed to Step 18
18		Measure voltage from IC2-5 to TP5 (return)	more than +0.1V	Defective IC2
			less than +0.1V	Defective IC2 Shorted CR2 or associated Component

TABLE 6-5

TROUBLESHOOTING THE -10V SUPPLY

Step	Symptom	Procedure	Indication	Conclusion
1	High Output	Measure +15V Supply	High Output	Defective +15V Supply
			Normal Output	Proceed to Step 2
2		Measure Voltage from A3 Q1 base to TP5 (return)	less than -10½V	Defective A3Q1
			more than -10½V	Proceed to Step 3
3		Measure Voltage from IC1-4 to TP5 (return)	more than -0.1V	Defective IC1
			more than +0.1V	Defective R1 or R3
			less than ±0.1V	Shorted CR1
4	Low Output	Measure +15V Supply	Low Output	Defective +15V Supply
			Normal Output	Proceed to Step 5
5		Measure Voltage from A5Q1 base to TP5 (return)	more than -10½V	Defective A3Q1 or associated Component or Output of Supply Shorted
			less than -10½V	Proceed to Step 6
6		Measure Voltage from IC1-4 to TP5 (return)	more than +0.1V	Defective IC1
			more than -0.1V	Defective R1, R3 or C3
			less than ±0.1V	Shorted CR1

TABLE 6-6

TYPICAL VOLTAGES AT RECTIFIER AND FILTER CIRCUITS
ASSEMBLY A4

Function	Connections	Typical DC Volts*	Typical Ripple* Volts Peak to Peak under Load
UNREGULATED INPUT TO +15V SUPPLY	+A5 J5-10 - J5- 1	22	2
UNREGULATED INPUT TO -15V SUPPLY	+ J5-21 - J5-15	22	2
UNREGULATED INPUT TO Y16 SUPPLY	+ J5-24 - J5-16	28	5
UNREGULATED INPUT TO BIAS SUPPLY	+ J5-20 - J5-17	33	2
UNREGULATED 200V SUPPLY	+ J5- 8 - J5- 2	210	6
UNREGULATED 100V SUPPLY	+ J5- 9 - J5- 5	105	3

* Use differential input oscilloscope, or other ungrounded voltmeter.

TABLE 6-7
TYPICAL VOLTAGES AT +AND -15V REGULATOR
-10V REFERENCE SUPPLIES
ASSEMBLY A3
with respect to A5J4-17 (circuit ground)

Pin Number	Typical DC Volts	Typical Noise and Ripple Peak to Peak Volts
1	-10.000	0.001
2	+15.000	0.001
3	0	0
4	-15.000	0.001
5	NC	NC
6	- 15	0.01
7	NC	NC
8	NC	NC
9	+ 6	2
10	+ 1	0.1
11	+ ¼	0.01
12	NC	NC
13	NC	NC
14	- 6	2
15	- 1	0.1
16	- ¼	0.01
17	0	0
18	NC	NC
19	± 1½V depending on RF Unit	0.1
20	+ 1 or 0 "	0.1 or 0
21	NC	NC
22	0	0
23	+ ¼ or 0 depending on RF Unit	0.01
24	+ 15	0.01

TABLE 6-8
TYPICAL VOLTAGES AT MARKER GENERATOR, GENERATOR ASSEMBLY A2
with respect to A5J3-13 (circuit ground)

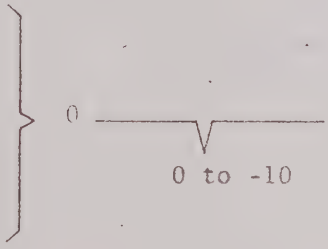
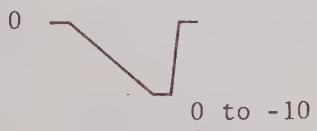
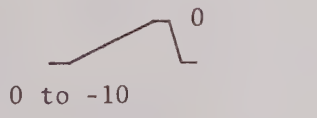
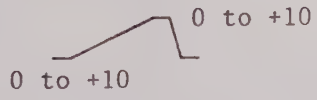
Pin Number	Typical DC Volts	Controlled by	Typical Waveform or AC Peak to Peak Volts
1	+15		.01 max ripple and noise
2	-15		.01 max ripple and noise
3	0 to -10	M2 or F2	.01 max ripple and noise
4	+ 9	1 KHz ON	2V p-p at 1 KHz
5	0 to -10	M1 or F1	.01 max ripple and noise
6	0 to +10	Mainframe front panel settings	
7	0		.01 max ripple and noise
8	-15		.1 max ripple and noise
9-12	NC		NC
13	0		0
14	NC		NC
15	+10	1 KHz ON	2V p-p at 1 KHz
16	-	Mainframe front panel setting	
17	-	RF Marker ON/OFF	
18	-	Marker Amplitude	
19	-	Marker Amplitude	
20	-	RF During Retrace	
21	-	1KHz ON RF During Retrace Marker Amplitude	
22	-9½	1KHz	2V p-p at 1KHz
23	+15V	1KHz ON	0.1 max ripple and noise
24	+15V		0.1 max ripple and noise

TABLE 6-9
TYPICAL VOLTAGES AT SWEEP WAVEFORM GENERATOR
ASSEMBLY A1
with respect to A5J2-1 (circuit ground)

Pin Number	Typical DC Volts	Controlled by	Typical Waveform or AC Peak to Peak Volts
A5J1-1	+15		.1 max ripple and noise
2	-15		.1 max ripple and noise
3	0		.01 max ripple and
4	0		.01 max ripple and
5		A	
6 and 7	0 or Waveform	A	
8		A	
9	+15	A	.01 max ripple and noise
10	-15		.01 max ripple and noise
11		A	
12		A M2, F2	
13		A M1, F1	
14		A M1,2, F1,2	
15	-15V through 5 megohm		-

A Mainframe Front Panel Settings

TABLE 6-9 Cont'd.
ASSEMBLY A1
with respect to A5J2-1 (circuit ground)

Pin Number	Typical DC Volts	Controlled by	Typical Waveform or AC Peak to Peak Volts
A5J2-1	0		0
2	+ 1 +100	forward trace A retrace or no sweep A	
3	0 - 10	forward trace A retrace A	
4	+ 2 - 12	forward trace A retrace A	
5		A	same as J2-9 in AUTO J2-8 in LINE, EXT, SINGLE SWEEP
6	0		0.01 max ripple and noise
7	0 AUTO LINE EXT -10V transient each single sweep	TRIGGER	LINE 10V p-p at line freq.
8	- 11 to - 1	A	similar to J2-9
9		A	
10		A and RF UNIT	Proportional to instantaneous frequency 0 at low end of band on order of +10V at high end of band
11		A and RF UNIT	same as 10, scale factor 40V/Octave
12	+105		3V p-p
13	+ ½ when	SWEEP TIME (Sec) is 1 or 10	
14 and 15		A	Continuity during forward trace when SWEEP TIME is 1 or 10 open circuited otherwise

A - SWEEP FUNCTION, SWEEP TIME, AND TRIGGER

SECTION 7-0

REPLACEABLE PARTS

7-1. INTRODUCTION. This section provides information for procuring replacement parts for the Model 230A. Table 7-2 provides an alpha-numerical list, by reference designation, of all parts. The following information is given, when applicable, for each part listed:

a. Micro-Power part number.
b. Description of part.
c. Typical manufacturer and manufacturer's part number.

7-2. REFERENCE DESIGNATIONS AND ABBREVIATIONS. See Table 7-1 for a complete explanation of reference designations and abbreviations.

7-3. ORDERING INFORMATION. The following information should be included on purchase order when ordering replacement parts from the Micro-Power Corporation:

a. The Micro-Power part number and part description.
b. The instrument's model number and serial number.
c. If ordering a part not included in Table 7-2, include a complete description of the part, its function and its location within the equipment.

The following information should be included on purchase order when ordering replacement parts from another manufacturer:

The complete description of the part and manufacturer's part number for the part as they appear in Table 7-2.

TABLE 7-1

ABBREVIATIONS AND REFERENCE DESIGNATIONS

All reference designations for electrical parts will be preceded by a prefix which will indicate the assembly in which it is contained. These prefixes will be identified as follows:

A1 - SWEEP WAVEFORM GENERATOR - FIGURES 8-2 AND 8-3
A2 - MARKER GENERATOR/ . GENERATOR - FIGURE 8-4
A3 - + AND -15V REGULATOR/-10V REF SUPPLY - FIGURE 8-5
A4 - RECTIFIER AND FILTER CIRCUITS - FIGURE 8-5
A5 - INTERCONNECTING BOARD - Figure 8-6
A6 - F1, M1, F2, M2 ALIGNMENT TRIMMERS - FIGURE 8-3
A7 - SPARE
*A8 - MAINFRAME ASSEMBLY - FIGURE 8-1

* Includes all parts within main frame not included in Assembly A1-A6.

ABBREVIATIONS

A-Amperes
AMPL-Amplifier
AM-Amplitude modulation
APPROX-Approximate
ASS'Y-Assembly
AUX-Auxiliary
AVG-Average
BAL-Balance
BWO-Backward wave oscillator
C-Cathode
CAL-Calibrator
CCW-Counterclockwise
CW-Clockwise
dB-Decibel
dBm-Decibel (referred to 1 milliwatt in 600 ohms)
EXT-External
F-Farad
FIG-Figure
FIX-Fixed
FM-Frequency modulate
A-Assembly
B-Motor
C-Capacitor
CR-Diode
DS-Lamp
F-Fuse
FWD-Forward
G-Giga=10^9
GRD-Ground
H-Henry
Hz-Cycle per second
IDENT-Identification
IMP-Impulse
INT-Internal
K-Kilo=10^3
LIN-Linear
M-Milli=10^{-3}
MAX-Maximum
MEG-Meg=10^6
MFG-Manufacturer
MIN-Minimum
N-Nano=10^{-9}
NC-Normally closed
NEG-Negative
NO-Normally open
Ω-Ohm
O-Peak
J-Jack
K-Relay
L-Inductor
M-Meter
P-Plug
Q-Transistor
PC-Printed Circuit
PF-Pico farads=10^{-12} farads
P/O-Part of
POT-Potentiometer
P-P-Peak to Peak
RECT-Rectifier
RES-Resistance or Resistor
RET-Return
REV-Reverse
RF-Radio Frequency
RMS-Square root of mean square
SEC-Second
SW-Switch
SYM-Symmetrical
TRIG-Trigger
TYP-Typical
U-Micro=10^{-6}
V-Volt
VAR-Variable
W-Watts
R-Resistor
S-Switch
T-Transformer
TB-Terminal board
TP-Test point
V-Vacuum
X-Socket

TABLE 7-2

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
A1	207-075	Sweep Waveform Generator		
A1C1	420-001	1000 pf 20% 1KV Cer	56289	5GA-D10
A1C2	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1C3	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1C4	420-001	1000 pf 20% 1 KV Cer	56289	5GA-D10
A1C5	430-035	.047 uf 400V Mylar	73445	C2 800
A1C6	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1C7	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1C8	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C9	460-100	10 pf 10% 500V Mica	84171	DM15-100K
A1C10	400-041	100 uf -10+100% 25V Elect	56289	TE 1211
A1C11	400-041	100 uf -10+100% 25V Elect	56289	TE 1211
A1C12	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C13	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1C14	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C15	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1C16	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C17	420-035	2000 pf 20% 1KV Cer	56289	5GA-D20
A1C18	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C19	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1C20	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C21	460-471	470 pf 10% 500V Mica	84171	DM15-471K
A1C22	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C23	460-221	220 pf 10% 500V Mica	841-1	DM15-221K
A1C24	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C25	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1C26	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C27	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1C28	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C29	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1C30	430-035	.047 uf 400V Mylar	73445	C2800
A1C31	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C32	430-019	4700 pf 10% 50V Mylar	84411	601PE
A1C33	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1C34	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A1CR1	501-007	Diode, Zener 6.2V		1N753A
A1CR2	500-010	Diode		1N914
A1CR3	500-010	Diode		1N914
A1CR4	500-010	Diode		1N914
A1CR5	500-010	Diode		1N914
A1CR6	500-010	Diode		1N914
A1CR7	500-010	Diode		1N914
A1CR8	500-010	Diode		1N914
A1CR9	500-010	Diode		1N914
A1CR10	500-010	Diode		1N914
A1CR11	500-010	Diode		1N914
A1CR12	500-010	Diode		1N914
A1CR13	500-010	Diode		1N914
A1CR14	500-010	Diode		1N914

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
A1CR15	500-010	Diode		1N914
A1CR16	500-010	Diode		1N914
A1CR17	500-010	Diode		1N914
A1CR18	500-010	Diode		1N914
A1CR19	500-010	Diode		1N914
A1CR20	500-010	Diode		1N914
A1CR21	500-010	Diode		1N914
A1CR22	500-010	Diode		1N914
A1CR23	500-010	Diode		1N914
A1CR24	500-010	Diode		1N914
A1CR25	500-010	Diode		1N914
A1CR26	500-010	Diode		1N914
A1CR27	500-010	Diode		1N914
A1CR28	500-010	Diode		1N914
A1CR29	500-010	Diode		1N914
A1CR30	500-010	Diode		1N914
A1CR31	500-010	Diode		1N914
A1CR32	500-010	Diode		1N914
A1CR33	500-010	Diode		1N914
A1CR34	500-010	Diode		1N914
A1CR35	501-007	Diode, Zener		1N753A
A1CR36	500-010	Diode		1N914
A1CR37	500-010	Diode		1N914
A1CR38	500-010	Diode		1N914
A1IC1	503-001	I. C. Amplifier	01295	SN72709N
A1IC2	503-001	I. C. Amplifier	01295	SN72709N
A1IC3	503-001	I. C. Amplifier	01295	SN72709N
A1IC4	503-001	I. C. Amplifier	01295	SN72709N
A1IC5	503-001	I. C. Amplifier	01295	SN72709N
A1IC6	503-001	I. C. Amplifier	01295	SN72709N
A1IC7	503-001	I. C. Amplifier	01295	SN72709N
A1IC8	503-001	I. C. Amplifier	01295	SN72709N
A1IC9	503-001	I. C. Amplifier	01295	SN72709N
A1IC10	503-001	I. C. Amplifier	01295	SN72709N
A1K1A	216-002	Relay Coil	18786	
A1K1B	211-014	Relay Contact	95348	MR 107
A1Q1	502-013	Transistor		2N3703
A1Q2	502-013	Transistor		2N3703
A1Q3	502-024	Transistor		2N5184
A1Q4	502-026	Transistor		2N2905A
A1Q5	502-026	Transistor		2N2905A
A1Q6	502-013	Transistor		2N3703
A1Q7	502-010	Transistor		2N3707
A1Q8	502-024	Transistor		2N5184
A1Q9	502-010	Transistor		2N3707
A1R1	300-475	4.7 Meg. Ohm 10% 1/4W Comp		RC07GF475K

TABLE 7-2 (CONT'D)

REPLACEABLE-PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
A1R2	300-103	10K Ohm 10% 1/4W Comp		RC07GF103K
A1R3	300-472	4700 Ohm 10% 1/4W Comp		RC07GF472K
A1R4	300-102	1000 Ohm 10% 1/4W Comp		RC07GF102K
A1R5	300-471	470 Ohm 10% 1/4W Comp		RC07GF471K
A1R6	300-102	1000 Ohm 10% 1/4W Comp		RC07GF102K
A1R7	300-472	4700 Ohm 10% 1/4W Comp		RC07GF472K
A1R8	300-103	10K Ohm 10% 1/4W Comp		RC07GF103K
A1R9	300-472	4700 Ohm 10% 1/4W Comp		RC07GF472K
A1R10	300-223	22K Ohm 10% 1/4W Comp		RC07GF223K
A1R11	300-223	22K Ohm 10% 1/4W Comp		RC07GF223K
A1R12	300-223	22K Ohm 10% 1/4W Comp		RC07GF223K
A1R13	300-472	4700 Ohm 10% 1/4W Comp		RC07GF472K
A1R14	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A1R15	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R16	300-222	2200 Ohm 10% 1/4W Comp		RC07GF222K
A1R17	300-683	68K Ohm 10% 1/4W Comp		RC07GF683K
A1R18	300-223	22K Ohm 10% 1/4W Comp		RC07GF223K
A1R19	300-223	22K Ohm 10% 1/4W Comp		RC07GF223K
A1R20	300-683	68K Ohm 10% 1/4W Comp		RC07GF683K
A1R21	300-222	2200 Ohm 10% 1/4W Comp		RC07GF222K
A1R22	300-103	10K Ohm 10% 1/4W Comp		RC07GF103K
A1R23	300-333	33K Ohm 10% 1/4W Comp		RC07GF333K
A1R24	300-103	10K Ohm 10% 1/4W Comp		RC07GF103K
A1R25	300-471	470 Ohm 10% 1/4W Comp		RC07GF471K
A1R26	315-061	10K Ohm 1% 1/8W Met.Film		RN60D1002F
A1R27	315-101	5620 Ohm 1% 1/8W Met.Film		RN60D5621F
A1R28	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A1R29	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R30	300-100	10 Ohm 10% 1/4W Comp		RC07GF100K
A1R31	300-100	10 Ohm 10% 1/4W Comp		RC07GF100K
A1R32	315-122	150K Ohm 1% 1/8W Met.Film		RN60D1503F
A1R33	300-472	4700 Ohm 10% 1/4W Comp		RC07GF472K
A1R34	315-061	10K Ohm 1% 1/8W Met.Film		RN60D1002F
A1R35	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A1R36	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R37	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R38	300-103	10K Ohm 10% 1/4W Comp		RC07GF103K
A1R39	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R40	300-103	10K Ohm 10% 1/4W Comp		RC07GF103K
A1R41	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A1R42	300-471	470 Ohm 10% 1/4W Comp		RC07GF471K
A1R43	300-101	100 Ohm 10% 1/4W Comp		RC07GF101K
A1R44	300-103	10K Ohm 10% 1/4W Comp		RC07GF103K
A1R45	300-103	10K Ohm 10% 1/4W Comp		RC07GF103K
A1R46	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R47	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A1R48	300-103	10K Ohm 10% 1/4W Comp.		RC07GF103K
A1R49	300-471	470 Ohm 10% 1/4W Comp		RC07GF471K
A1R50	300-101	100 Ohm 10% 1/4W Comp		RC07GF101K
A1R51	325-004	15K Ohm .05% 1/8W W.W.	91637	MWA-10
A1R52	325-003	10K Ohm .05% 1/8W W.W.	91637	MWA-10

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
A1R53	300-332	3300 Ohm 10% 1/4W Comp		RC07GS332K
A1R54	300-155	1.5 Meg.Ohm 10% 1/4W Comp		RC07GF155K
A1R55	304-006	10K Ohm 10% 1/2W W.W.LinVar	91637	2387
A1R56	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A1R57	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R58	315-061	10K Ohm 1% 1/8W Met Film		RN60D1002K
A1R59	315-061	10K Ohm 1% 1/8W Met Film		RN60D1002F
A1R60	315-061	10K Ohm 1% 1/8W Met Film		RN60D1002K
A1R61	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A1R62	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R63	300-222	2200 Ohm 10% 1/4W Comp		RC07GF222K
A1R64	300-153	15K Ohm 10% 1/4W Comp		RC07GF153K
A1R65	303-103	10K Ohm 10% 2W Comp		RC42GF103K
A1R66	300-102	1000 Ohm 10% 1/4W Comp		RC07GF102K
A1R67	325-003	10K Ohm .05% 1/8W W.W.	91637	MWA-10
A1R68	300-155	1.5 Meg.Ohm 10% 1/4W Comp		RC07GF155K
A1R69	304-006	10K Ohm 10% 1/2W W.W.LinVar	91637	2387
A1R70	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A1R71	325-003	10K Ohm .05% 1/8W W.W.	91637	MWA-10
A1R72	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R73	325-043	2000 Ohm .05% 1/8W W.W.	91637	MWA-10
A1R74	300-681	680 Ohm 10% 1/4W Comp		RC07GF681K
A1R75	325-043	2000 Ohm .05% 1/8W W.W.	91637	MWA-10
A1R76	300-474	470K Ohm 10% 1/4W Comp		RC07GF474K
A1R77	304-006	10K Ohm 10% 1/2W W.W.LinVar	91637	2387
A1R78	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A1R79	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R80	325-043	2000 Ohm .05% 1/8W W.W.	91637	MWA-10
A1R81	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R82	315-081	3010 Ohm 1% 1/8W Met.Film		RN60D3011F
A1R83	315-046	1960 Ohm 1% 1/8W Met.Film		RN60D1961F
A1R84	315-061	10K Ohm 1% 1/8W Met.Film		RN60D1002F
A1R85	300-027	2.7 Ohm 10% 1/4W Comp		RC07GF2R7K
A1R86	300-101	100 Ohm 10% 1/4W Comp		RC07GF101K
A1R87		Not Used		
A1R88	315-019	100K Ohm 1% 1/8W Met.Film		RN60D1003F
A1R89	315-019	100K Ohm 1% 1/8W Met.Film		RN60D1003F
A1R90	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A1R91	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A1R92	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R93	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A1R94	300-101	100 Ohm 10% 1/4W Comp		RC07GF101K
	223-007	Card Puller/Roll Pins	97525	H903
	223-011	I.C. Socket 14 Pin	91506	314-AG5D-2
	223-007	Pad, Transistor, TO-5	07047	A-10029
A2	207-071	Marker Generator/Square Wave Gen.		
A2C1	460-470	47 pf 10% 500V Mica	84171	DM15-470K

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
A2C2	415-005	3.3 pf 5% Fxd.Comp		
A2C3	460-470	47 pf 10% 500V Mica	84171	DM15-470K
A2C4	415-005	3.3 pf 5% Fxd.Comp		
A2C5	400-041	100 uf -10+100% 25V Elect	56289	TE1211
A2C6	430-011	0.1 uf 10% 50V Mylar	84411	601PE
A2C7	400-041	100 uf -10+100% 25V Elect	56289	TE1211
A2C8	460-150	15 pf 10% 500V Mica	84171	DM15-150K
A2C9	460-150	15 pf 10% 500V Mica	84171	DM15-150K
A2CR1		Not Used		
A2CR2		Not Used		
A2CR3	500-010	Diode		1N914
A2CR4	500-010	Diode		1N914
A2CR5	500-010	Diode		1N914
A2CR6	500-010	Diode		1N914
A2CR7	500-010	Diode		1N914
A2CR8		Not Used		
A2CR9	500-010	Diode		1N914
A2CR10		Not Used		
A2CR11	500-010	Diode		1N914
A2CR12	500-010	Diode		1N914
A2CR13	500-010	Diode		1N914
A2CR14	500-010	Diode		1N914
A2CR15	500-010	Diode		1N914
A2CR16	501-008	Diode, Zener		1N759A
A2CR17	500-010	Diode		1N914
A2CR18	500-010	Diode		1N914
A2CR19	500-010	Diode		1N914
A2CR20	500-010	Diode		1N914
A2CR21	500-010	Diode		1N914
A2CR22	500-010	Diode		1N914
A2CR23	500-010	Diode		1N914
A2CR24	500-010	Diode		1N914
A2CR25	500-010	Diode		1N914
A2CR26	500-010	Diode		1N914
A2IC1	503-001	I. C. Amplifier	01295	SN72709N
A2IC2	503-001	I. C. Amplifier	01295	SN72709N
A2Q1	502-010	Transistor		2N3707
A2Q2	502-013	Transistor		2N3703
A2Q3	502-010	Transistor		2N3707
A2Q4	502-013	Transistor		2N3703
A2Q5	502-010	Transistor		2N3707
A2Q6	502-010	Transistor		2N3707
A2Q7	502-010	Transistor		2N3707
A2Q8	502-013	Transistor		2N3703
A2Q9	502-013	Transistor		2N3703

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
A2R1	304-006	10K Ohm 10% 1/2W W.W.LinVar	91637	2387
A2R2	304-006	10K Ohm 10% 1/2W W.W.LinVar	91637	2387
A2R3	325-045	100K Ohm .05% 1/8W W.W.	91637	MWA-10
A2R4	300-155	1.5Meg Ohm 10% 1/4W Comp		RC07GF155K
A2R5		0 Ohms		
A2R6		Not Used		
A2R7		0 Ohms		
A2R8		Not Used		
A2R9	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A2R10	315-013	2800 Ohm 1% 1/8W Met.Film		RN60D2801F
A2R11	315-013	2800 Ohm 1% 1/8W Met.Film		RN60D2801F
A2R12	315-013	2800 Ohm 1% 1/8W Met.Film		RN60D2801F
A2R13	315-011	1400 Ohm 1% 1/8W Met.Film		RN60D1401F
A2R14	300-104	100K Ohm 10% 1/4W Comp		RC07GF104K
A2R15	300-102	1000 Ohm 10% 1/4W Comp		RC07GF102K
A2R16	300-153	15K Ohm 10% 1/4W Comp		RC07GF153K
A2R17	315-038	4320 Ohm 1% 1/8W Met Film		RN60D4321F
A2R18	325-045	100K Ohm .05% 1/8W W.W.		MWA-10
A2R19	300-155	1.5Meg Ohm 10% 1/4W Comp		RC07GF155K
A2R20		0 Ohms		
A2R21		0 Ohms		
A2R22		Not Used		
A2R23	300-100	10 Ohm 10% 1/4W Comp		RC07GF100K
A2R24		Not Used		
A2R25	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A2R26	315-013	2800 Ohm 1% 1/8W Met.Film		RN60D2801F
A2R27	315-013	2800 Ohm 1% 1/8W Met.Film		RN60D2801F
A2R28	315-013	2800 Ohm 1% 1/8W Met.Film		RN60D2801F
A2R29	315-011	1400 Ohm 1% 1/8W Met.Film		RN60D1401F
A2R30	300-104	100K Ohm 10% 1/4W Comp		RC07GF104K
A2R31	300-102	1000 Ohm 10% 1/4W Comp		RC07GF102K
A2R32	300-153	15 K Ohm 10% 1/4W Comp		RC07GF153K
A2R33	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A2R34	300-153	15K Ohm 10% 1/4W Comp		RC07GF153K
A2R35	300-101	100 Ohm 10% 1/4W Comp		RC07GF101K
A2R36	300-101	100 Ohm 10% 1/4W Comp		RC07GF101K
A2R37	300-472	4700 Ohm 10% 1/4W Comp		RC07GF472K
A2R38	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A2R39	300-104	100K Ohm 10% 1/4W Comp		RC07GF104K
A2R40	300-102	1000 Ohm 10% 1/4W Comp		RC07GF102K
A2R41	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A2R42	300-472	4700 Ohm 10% 1/4W Comp		RC07GF472K
A2R43	315-027	3160 Ohm 1% 1/8W Met.Film		RN60D3161F
A2R44	300-682	6800 Ohm 10% 1/4W Comp		RC07GF682K
A2R45	315-111	5110 Ohm 1% 1/8W Met.Film		RN60D5111F
A2R46	300-100	10 Ohm 10% 1/4W Comp		RC07GF100K
A2R47	315-055	2490 Ohm 1% 1/8W Met Film		RN60D2491F
A2R48	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A2R49	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A2R50	325-045	100K Ohm .05% 1/8W W.W.	91637	MWA-10
A2R51	325-044	100K Ohm .01% 1/8W W.W.	91637	MWA-10

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFR. PART NO.
A2R52	300-104	100K Ohm 10% 1/4W Comp		RC07GF104K
A2R53	300-100	10 Ohm 10% 1/4W Comp		RC07GF100K
A2R54	300-473	47K Ohm 10% 1/4W Comp		RC07GF473K
A2R55	300-104	100K Ohm 10% 1/4W Comp		RC07GF104K
A2R56	300-100	10 Ohm 10% 1/4W Comp		RC07GF100K
A2R57	300-473	47K Ohm 10% 1/4W Comp		12C07GF473K
A2R58	300-104	100K Ohm 10% 1/4W Comp		RC07GF104K
A2TP1-7	899-003	Terminal Lug	86577	2S4-38B
	233-011	I. C. Socket 14 Pin	91506	314-AG5D-2
	223-007	Handle, Card Puller	97525	H903
A3	207-074	+ and -15V Regulator/-10V Ref.Sup		
A3C1	430-019	4700 pf 10% 50V Mylar	84411	601PE
A3C2	400-041	100 uf -10+100% 25V Elect	56289	TE1211
A3C3	430-032	0.22 uf 10% 50V Mylar	84411	601PE
A3C4	460-221	200 pf 10% 500V Mica	84171	DM15-221K
A3C5	400-019	1000 uf -10+100% 25V Elect	56289	39D108G025 GL4
A3C6	430-032	0.22 uf 10% 50V Mylar	84411	601PE
A3C7	430-032	0.22 uf 10% 50V Mylar	84411	601PE
A3C8	430-019	4700 pf 10% 50V Mylar	84411	601PE
A3C9	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A3C10	400-019	1000 uf -10+100% 25V Elect	56289	39D108G025 GL4
A3C11	430-032	0.22 uf 10% 50V Mylar	84411	601PE
A3C12	430-019	4700 pf 10% 50V Mylar	84411	601PE
A3C13	460-221	220 pf 10% 500V Mica	84171	DM15-221K
A3C14	430-032	0.22 uf 10% 50V Mylar	84411	601PE
A3CR1	500-010	Diode		1N914
A3CR2	500-010	Diode		1N914
A3CR3	501-019	Diode, Zener		1N3499
A3CR4	500-010	Diode		1N914
A3CR5	500-010	Diode		1N914
A3CR6	500-010	Diode		1N914
A3CR7	500-010	Diode		1N914
A3IC1	503-001	I. C. Amplifier	01295	SN72709N
A3IC2	503-001	I. C. Amplifier	01295	SN72709N
A3IC3	503-001	I. C. Amplifier	01295	SN72709N
A3Q1	502-007	Transistor		2N1131
A3Q2	502-005	Transistor		2N697
A3Q3	502-010	Transistor		2N3707
A3Q4	502-012	Transistor		2N3702
A3Q5	502-007	Transistor		2N1131
A3Q6	502-010	Transistor		2N3707
A3Q7	502-010	Transistor		2N3707
A3R1	325-042	3000 Ohm .05% 1/8W W.W.	91637	MWA-10
A3R2	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
A3R3	325-043	2000 Ohm .05% 1/8W W.W.	91637	MWA-10
A3R4	302-100	10 Ohm 10% 1W Comp		RC32GF100K
A3R5	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A3R6	325-003	10K Ohm .05% 1/8W W.W.	91637	MWA-10
A3R7	300-472	4700 Ohm 10% 1/4W Comp		RC07GF472K
A3R8	300-152	1500 Ohm 10% 1/4W Comp		RC07GF152K
A3R9	325-003	10K Ohm .05% 1/8W W.W.	91637	MWA-10
A3R10	302-R47	0.47 Ohm 10% 1W Comp	81483	BWH-1
A3R11	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A3R12	315-071	21.5KOhm 1% 1/8W Met.Film		RN60D2152F
A3R13	300-103	10K Ohm 10% 1/4W Comp		RC07GF103K
A3R14	315-040	1270 Ohm 1% 1/8W Met Film		RN60D1271F
A3R15	325-004	15K Ohm .05% 1/8W W.W.	91637	MWA-10
A3R16	304-005	1000 Ohm 10% 1/2W W.W.LinVar	91637	2387
A3R17	300-152	1500 Ohm 10% 1/4W W.W.		RC07GF152K
A3R18	302-R47	0.47 Ohm 10% 1W Comp	81483	BWH-1
A3R19	300-221	220 Ohm 10% 1/4W Comp		RC07GF221K
A3R20	300-473	47K Ohm 10% 1/4W Comp		RC07GF473K
A3R21	300-473	47K Ohm 10% 1/4W Comp		RC07GF473K
A3R22	302-R47	.47 Ohm 10% 1W Comp	81483	BWH-1
A3R23	300-471	470 Ohm 10% 1/4W Comp		RC07GF471K
A3R24	302-470	47 Ohm 10% 1W Comp		RC32GF470K
A3TP1	899-003	Terminal Lug	86577	2S4-38B
A3TP2	899-003	Terminal Lug	86577	2S4-38B
A3TP3	899-003	Terminal Lug	86577	2S4-38B
A3TP4	899-003	Terminal Lug	86577	2S4-38B
A3TP5	899-003	Terminal Lug	86577	2S4-38B
A3TP6	899-003	Terminal Lug	86577	2S4-38B
A3TP7	899-003	Terminal Lug	86577	2S4-38B
A3TP8	899-003	Terminal Lug	86577	2S4-38B
A3TP9	899-003	Terminal Lug	86577	2S4-38B
	223-007	Handle, Card Puller	97525	H903
	233-007	Transistor Pad	07047	A-10029
	233-011	I. C. Sockets 14 Pin	91506	314-AG5D-2
	899-913	Tie Wrap	59730	TY-23M
A4	207-073	Rectifier and Filter Circuits		
A4C1	400-002	40 uf -10+50% 450V Elect	74861	40B838RM
A4C2	400-002	40 uf -10+50% 450V Elect	74861	40B838RM
A4C3	400-057	2200 uf -10+100% 25V Elect	56289	39D228G025 HP4
A4C4	400-057	2200 uf -10+100% 25V Elect	56289	39D228G025 HP4
A4C5	400-051	1000 uf -10+100% 40V Elect	56289	39D108G040 GP4
A4C6	400-051	1000 uf -10+100% 40V Elect	56289	39D108G040 GP4

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
A4C7	420-023	0.1 uf ±20% 500V Cer	56289	5HK-P10
A4C8	420-023	0.1 uf ±20% 500V Cer	56289	5HK-P10
A4CR1	500-005	Diode	14099	SCE2
A4CR2	500-005	Diode	14099	SCE2
A4CR3	500-005	Diode	14099	SCE2
A4CR4	500-005	Diode	14099	SCE2
A4CR5	500-005	Diode	14099	SCE2
A4CR6	500-005	Diode	14099	SCE2
A4CR7	500-005	Diode	14099	SCE2
A4CR8	500-005	Diode	14099	SCE2
A4CR9	500-005	Diode	14099	SCE2
A4CR10	500-005	Diode	14099	SCE2
A4CR11	500-005	Diode	14099	SCE2
A4CR12	500-005	Diode	14099	SCE2
A4CR13	500-005	Diode	14099	SCE2
A4CR14	500-005	Diode	14099	SCE2
A4CR15	500-005	Diode	14099	SCE2
A4CR16	500-005	Diode	14099	SCE2
A4CR17	500-005	Diode	14099	SCE2
A4CR18	500-005	Diode	14099	SCE2
A4CR19	500-005	Diode	14099	SCE2
A4CR20	500-005	Diode	14099	SCE2
A4CR21	500-005	Diode	14099	SCE2
A4CR22	500-005	Diode	14099	SCE2
A4CR23	500-005	Diode	14099	SCE2
A4CR24	500-005	Diode	14099	SCE2
A4R1	303-104	100K Ohm 10% 2W Comp		RC42GF104K
A4R2	300-683	68K Ohm 10% 1/4W Comp		RC07GF683K
A4R3	300-682	6800 Ohm 10% 1/4W Comp		RC07GF682K
A4TP1-4	899-003	Small Single Tier Solder Lug	865-7	2S4-38B
	899-001	Large Double Tier Solder Lug	86577	2D6-29B
	899-913	Tie Wrap	59730	TY-23M
	899-914	Tie Wrap	59730	TY-23M
	205-225	Plate, Shield	18786	
	223-007	Handle, Card Puller	97525	H903
A5	207-078	Interconnection P.C. Bd.Ass'y		
A5A1	250-009	Sweep Function Switch Ass'y	18786	
A5A2	250-010	Sweep Time Switch Ass'y	18786	
A5C1	430-026	0.22 uf 10% 200V Mylar	84411	X663F
A5C2	430-026	0.22 uf 10% 200V Mylar	84411	X663F
A5C3	420-023	0.1 uf 10% 1KV Cer	56289	5HK-P10
A5CR1	500-005	Diode	14099	SCE2

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
A5J1	234-047	Connector, P.C., 15 Pin	95354	91-6015-1300-00
A5J2	234-047	Connector, P. C., 15 Pin	95354	91-6015-1300-00
A5J3	234-048	Connector, P. C., 24 Pin	95354	91-6024-1300-00
A5J4	234-048	Connector, P. C., 24 Pin	95354	91-6024-1300-00
A5J5	234-048	Connector, P. C., 24 Pin	95354	91-6024-1300-00
A5Q1	502-030	Transistor	01295	T1P-34A
A5Q2	502-019	Transistor	89869	DTS-423
A5Q3	502-010	Transistor		2N3707
A5Q4	502-018	Transistor		2N3055
A5Q5	502-018	Transistor		2N3055
A5R1	300-027	2.7 Ohm 10% 1/4W Comp		RC07GF2R7K
A5R2	307-003	0.68 Ohm 10% 1W W. W.	81483	BWH-1
A5R3	300-100	10 Ohm 10% 1/4W Comp		RC07GF100K
A5R4	300-100	10 Ohm 10% 1/4W Comp		RC07GF100K
A5R5	300-100	10 Ohm 10% 1/4W Comp		RC07GF100K
A5R6	300-100	10 Ohm 10% 1/4W Comp		RC07GF100K
A5R7	300-473	47K Ohm 10% 1/4W Comp		RC07GF473K
A5R8	300-333	33K Ohm 10% 1/4W Comp		RC07GF333K
A5R9	300-333	33K Ohm 10% 1/4W Comp		RC07GF333K
A5R10	300-474	470K Ohm 10% 1/4W Comp		RC07GF474K
A5R11	325-012	7500 Ohm .05% 1/8W W.W.	91637	MWA-10
A5R12	325-003	10K Ohm .05% 1/8W W.W.	91637	MWA-10
A5R13	325-003	10K Ohm .05% 1/8W W.W.	91637	MWA-10
A5R14	300-472	4700 Ohm 10% 1/4W Comp		RC07GF472K
A5R15	315-051	147K Ohm 1% 1/8W Met.Film		RN60D1473F
A5R16	301-681	680 Ohm 10% 1/2W Comp		RC20GF681K
A5R17	300-220	22 Ohm 10% 1/4W Comp		RC07GF220K
A5R18	300-105	1 Meg Ohm 10% 1/4W Comp		RC07GF105K
A5S1	210-027	Switch, Rotary		
	205-252	Support, Interconnection Bd.	18786	
	205-253	Support, Interconnection Bd.	18786	
	205-245	Shim, Conn.	18786	
	201-032	Eyelet, Funnel Fl., Copper	57771	A2130
	233-005	Socket, Transistor		
	201-043	Socket, P. C. Pin	00779	331892
	897-903A	Spacer - 1/4" lg	02768	212-180402-15-0101
A5A1	250-009	Sweep Function Sw. Ass'y		
A5A1S1	210-045	Switch, Rotary	18786	
A5A1R1	325-012	7500 Ohm .05% 1/8W W.W.	91637	MWA-10
A5A1R2	325-004	15K Ohm .05% 1/8W W.W.	91637	MWA-10

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
A5A2	250-010	Sweep Time Switch Assy		
A5A2C1	430-011	0.1 uf 10% 50V Mylar	84411	601PE
A5A2C2	440-041	1 uf 20% 20V Tant	56289	150D105X0020A2
A5A2C3	440-040	10 uf 20% 20V Tant	56289	150D106X0020B2
A5A2C4	440-042	100 uf 20% 20V Tant	56289	150D107X0020S2
A5A2R1	P/O A5A2S1	1.5 Meg. ohm Pot		
A5A2R2	300-154	150 K ohm 10% 1/4W Comp		RC07GF154K
A5A2R3	300-155	1.5 Meg. ohm 10% 1/4W Comp		RC07GF155K
A5A2S1	210-044	Switch, Rotary		
A6	207-077	F1, M1, M2, F2 Alignment Trimmers P.C. BD ASSY		
A6R1	304-035	10 ohm 10% 1/2W WW Lin Var	91637	2387
A6R2	304-035	10 ohm 10% 1/2W WW Lin Var	91637	2387
A6R3	304-035	10 ohm 10% 1/2W WW Lin Var	91637	2387
A6R4	304-035	10 Ohm 10% 1/2W WW Lin Var	91637	2387
A6R5	304-035	10 ohm 10% 1/2W WW Lin Var	91637	2387
A6R6	304-035	10 ohm 10% 1/2W WW Lin Var	91637	2387
A6R7	304-035	10 ohm 10% 1/2W WW Lin Var	91637	2387
A6R8	304-035	10 ohm 10% 1/2W WW Lin Var	91637	2387
A6R9	315-019	100 K ohm 1% 1/8W Met Film		RN60D1003F
A6R10	315-019	100 K ohm 1% 1/8W Met Film		RN60D1003F
A6R11	315-019	100 K ohm 1% 1/8W Met Film		RN60D1003F
A6R12	315-019	100 K ohm 1% 1/8W Met Film		RN60D1003F
	201-032	Eyelet, Funnel Flange, Copper	57771	A2130
A8	250-006	Main Frame Assy		
	621-002	Dial Mechanism Assy	18786	
A8DS1		Indicator - P/O A8S1		
A8DS2	214-010	Indicator	24455	5AB-A
A8F1	212-002	Fuse 3 Amp (115 V Line)	75915	312003
A8F1	212-007	Fuse 1.5 Amp (230 V Line)	75915	31201.5
A8J1	234-003	Connector BNC		UG1094A/U
A8J2	234-003	Connector BNC		UG1094A/U
A8J3	234-003	Connector BNC		UG1094A/U
A8J4	234-003	Connector BNC		UG1094A/U

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
A8J5	234-003	Connector BNC		UG1094A/U
A8J6	234-003	Connector BNC		UG1094A/U
A8J7	234-003	Connector BNC		UG1094A/U
A8J8	234-050	Connector Receptacle 36 Pin	02660	57-20360
A8J9	234-003	Connector BNC		UG1094A/U
A8J10	234-017	Receptacle AC	60437	106S-1
A8R1		Listed with Dial Mechanism		
A8R2		Listed with Dial Mechanism		
A8R3		Listed with Dial Mechanism		
A8R4		Listed with Dial Mechanism		
A8R5	304-036	1000 ohm 10% 1/4W Var	01121	WA2G056S102UA
A8R6	304-010	10 K ohm 10% 1/2W Var		
A8R7	300-472	4700 ohm 10% 1/4W Comp		RC07GF472K
A8R8	300-472	4700 ohm 10% 1/4W Comp		RC07GF472K
A8R9	300-222	2200 ohm 10% 1/4W Comp		RC07GF222K
A8R10	300-222	2200 ohm 10% 1/4W Comp		RC07GF222K
A8R11	300-223	22 K ohm 10% 1/4W Comp		RC07GF223K
A8R12,R13	300-472	4700 ohm 10% 1/4 Comp		RC07GF472K
A8S1	210-037	Switch, Presslite	87834	616-6-1-A1H
A8S2	210-032	Switch, DPDT, Locking A.C.	82389	46256LF
A8S3	210-038	Switch, SPDT	95146	MSS-22
A8S4	210-033	Switch, DPDT, Locking	82389	46206L
A8S5	210-033	Switch, DPDT, Locking	82389	46206L
A8S6	210-033	Switch, DPDT, Locking	82389	46206L
A8S7	210-033	Switch, DPDT, Locking	82389	46206L
A8S8	210-033	Switch, DPDT, Locking	82389	46206L
A8T1	200-027	Transformer, Power	18786	
A8TB1	236-010	Terminal Block	75382	410-Y-11
A8W1	224-002	Line Cord	70903	17258
A8W2	242-001	Harness	18786	
	205-249	Strike Plate	18786	
	205-248	Fastener Strip	18786	
	205-247	Stiffener, Panel, Bot	18786	
	120-007	Trim, Front Handle	18786	
	205-244	Lamp Holder	18786	
	205-250	Center Support	18786	
	204-069	Crystal Lamp	18786	
	205-268	Cover, Access Hole	18786	
	205-266	Plate, Handle, Top	18786	
	205-267	Plate, Handle, Bottom	18786	
	205-254	Bracket, Conn.	18786	
	205-290	Mtg. Brkt., Pot	18786	

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
	205-257	Panel, Rear	18786	
	205-256	Panel, Front	18786	
	205-258	Side Panel, Inside Left	18786	
	205-259	Side Panel, Outside Left	18786	
	205-260	Side Panel, Inside Right	18786	
	205-261	Side Panel, Outside Right	18786	
	205-262	Dust Cover, Top	18786	
	205-263	Dust Cover, Bot.	18786	
	205-264	Dust Cover, Right Side	18786	
	205-265	Dust Cover, Left Side	18786	
	120-008	Bushing, Insulating	08289	BNC-375
	223-005	Handle, Carrying	12136	1775-354-383
	223-006	Handle, Front Panel	10110	H5
	120-009	Bail, 15½" Ctrs.	21604	
	217-010	Knob, Rd., Black	21604	SSN-70-2(BLK)
	201-053	Retaining Washer	71286	5S3-1 71&SKIRT
	217-011	Knob, Rd., Skirted, Black	21604	SSN-70TSL-2(BLK)
	217-012	Knob, Rd.	21604	SSN-50-1(RED)SHO
	217-013	Knob, Rd., Bar, Black	NOBEX	128-¼ SHAFT
	217-014	Knob, Rd., Black With White Line	21604	SS-50L-2(BLK)
	868-003	Nut, Knurl, 3/8-32NC	07173	071112
	868-004	Nut, Cap, #8-32 18.8 St.STL.	70318	
	213-001	Fuse Holder	75915	342004
	899-915	Rivet, Nylon	08863	N277
	120-010	Bearing, Teflon	96881	4L2-FF
	201-044	Screw, Captive	06540	6100-SS-0440
	899-914	Tie Wrap	59730	TY-34M
	839-701	Gnd. Lug., Chassis 6-32	83330	1416-6
	829-001	Gnd. Lug., Chassis 4-40	83330	1416-4
	899-912	Gnd. Lug., BNC	79963	334
	899-909	Clamp, Cable	83330	777
	201-030	Spacer	83330	2103
	899-906	Term, Feedthru	98291	FTE-15
	150-001	Tape, Self-Adhesive Polyester Foam Cushion		
	201-046	Receptacles, Fastener Stud	71286	5R2-3
	201-052	Stud, Fastener, Assembly	71286	557-8
	201-057	Retaining Ring	06540	4382-1-SS
	201-059	Key, Polarizing	95354	116-1008
	621-002	Dial Mechanism		
A8R1	304-030	1000 ohm 5% 2W Var	80294	3509S-402-102
A8R3	304-030	1000 ohm 5% 2W Var	80294	3509S-402-102
A8R3	304-030	1000 ohm 5% 2W Var	80294	3509S-402-102
A8R4	304-030	1000 ohm 5% 2W Var	80294	3509S-402-102
	204-065	Cursor		
	120-012	Decal, F1	18786	
	120-013	Decal, F2	18786	
	120-014	Decal, M1	18786	
	120-015	Decal, M2	18786	
	204-056	Shaft, Idler	18786	

TABLE 7-2 (CONT'D)

REPLACEABLE PARTS

REFERENCE DESIGNATION	MICRO-POWER PART NUMBER	DESCRIPTION	CODE IDENT	MFG PART NO.
	205-226	Bracket, Idler	18786	
	204-059	Spacer	18786	
	204-060	Spacer	18786	
	204-061	Pulley, Drive	18786	
	205-227	Plate, Rear	18786	
	204-062	Housing	18786	
	602-004	Slug, Setscrew	18786	
	130-002	Braided Dacron Cord		Style 827 White
	227-002	Caterpillar Grommet	03296	G51-A
	201-015	Pulley, Nylon	06915	PV-1
	201-019	Pins, Fluted, 1/32D x 3/16L	18786	
	802-203A	Screw, F.H. 100° #8-80x¼LG	18786	
	807-223A	Spacer	06540	8015-SS-008
	837-20LB	Spacer	06540	9740-SS-8044
	814-101A	Setscrew #2.56	18786	
	140-002	Accessory Kit	18786	
	205-291	Rack Adapter, Right Side	18786	
	205-224	Rack Adapter, Left Side	18786	
	205-225	Panel Filler	18786	

TABLE 7-3

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00213	Sage Electronics Corp.	Rochester, N.Y.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock, Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00853	Sangamo Electric Co.,Pickens Div.	Pickens, S.C..
00929	Microlab, Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc.,.Transistor Products Div.	Dallas, Texas
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor & Materials Div.	Somerville, N.J.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03818	Parker Seal Co.	Los Angeles, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertsville, N.J.
04062	Arco Electronic Inc.	Great Neck N.Y.
04404	Dymec Div. of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products,Microwave Device Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Ariz.
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04811	Precision Coil Spring Co.	El Monte, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05397	Union Carbide Corp. Linde Div., Kemet Dept.	Cleveland, Ohio
05574	Viking Ind., Inc.	Canoga Park, Calif.
05624	Barber Colman Co.	[illegible] Ill.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering, Inc.	Wakefield, Mass.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch & Lomb Optical Co.	Rochester, N.Y.
06540	Amaton Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	[illegible]acook, N.H.
06812	Torrington Mfg.,Co., West Div.	Van Nuys, Calif.

TABLE 7-3 (CONT'D)

CODE LIST OF MANUFACTURERS (CONT'D)

Code No.	Manufacturer	Address
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07065	Line Electric Co.	Parsippany, N.J.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Bircher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect.Prod. Inc., Mt.View Operations	Mountain View, Calif.
07700	Technical Wire Products, Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway N.J.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Can.
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08718	ITT Cannon Electric, Inc., Phoenix Div.	Phoenix, Ariz.
08727	National Radio Lab. Inc.	Paramus, N.J.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Can.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12881	Metex Electronics Corp.	Clark, N.J.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermolloy	Dallas, Texas
13511	Amphenol Corp.	Los Gatos, Calif.
14099	Sem-Tech	Newbury Park, Calif.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Co.	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
16179	Omni-Spectra Inc.	Detroit, Ill.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
18083	Clevelite Corp. Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18486	TRW Elect.Comp. Div.	Des Plaines, Ill.

TABLE 7-3 (CONT'D)

CODE LIST OF MANUFACTURERS (CONT'D)

Code No.	Manufacturer	Address
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18786	Micro-Power Inc.	Long Island City, N.Y.
18911	Durant Mfg. Co.	Milwaukee, Wisc.
24455	G.E. Lamp Div.	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Can.
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
42190	Muter Co.	Chicago, Ill.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Electric Corp.	Bristol, Conn.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
6459	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, New York
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products, Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wisc.
71616	Commercial Plastics Co.	Chicago, Ill.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B.Jones Div.	Chicago, Ill.

TABLE 7-3 (CONT'D)

CODE LIST OF MANUFACTURERS (CONT'D)

Code No.	Manufacturer	Address
71984	Dow Corning Corp.	Midland, Mich.
72259	Nytronics Inc.	Berkeley Heights, N.J.
72619	Dialight Corp.	Brooklyn, N.Y.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72962	Elastic Stop Nut Corp.	Union, N.J.
73061	Hansen Mfg. Co. Inc.	Princeton, Ind.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73506	Bradley Semi-conductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74861	Industrial Condenser Corp.	Chicago, Ill.
74970	E.F. Johnson Co.	Waseca, Minn.
75263	Keystone Carbon Co. Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon N.Y.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77221	Phanostran Instrument & Electric Co.	South Pasadena Calif.
77342	American Machine & Foundry Co., Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So.Braintree, Mass.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78526	Stanwyck Winding Co.	Newburgh, N.Y.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80813	Dimco Gray Co.	Dayton, Ohio
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elect. Div. Litton Ind., Inc.	Oakville, Conn.
81483	International Rectifier Corp.	El Segundo, Calif.
81860	Barry Controls Div. Barry Wright Corp.	Watertown, Mass.
81862	Electric Components Corp.	Addison, Ill.
82142	Jeffers Electronics Div. of Speer Carbon Co.	Du Bois, Pa.
82219	Sylvania Electric Products, Inc., Electronic Tube Div.	Emporium, Pa.

TABLE 7-3 (CONT'D)

CODE LIST OF MANUFACTURERS (CONT'D)

Code No.	Manufacturer	Address
82389	Switchcraft, Inc.	Chicago, Ill.
82866	Research Products Corp.	Madison, Wisc.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
86684	Radio Corp. of America, Electronic Comp & Devices Div.	Harrison, N.J.
87034	Marco Industries	Anaheim, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Could-National Batteries, Inc.	St. Paul, Minn.
89251	Graybar Electric Co.	Oakland, Calif.
90030	United Shoe Machinery Corp.	Beverly, Mass.
91146	ITT Cannon Elect. Inc. Salem Div.	Salem, Mass.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co.,	Wakefield, Mass.
91929	Honeywell Inc., Micro Switch Div.	Freeport Ill.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93929	G.V. Controls	Livingston, [illegible]
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	[illegible], Mass.
94148	Scientific Electronics Products, Inc.	[illegible]land, [illegible].
94154	Wagner Elect. Corp. Tung-Sol Div.	[illegible]ark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	[illegible] Paterson, N.J.
94375	Automatic Metal Products Co.	[illegible]lyn, N.Y.
95238	Continental Connector Corp.	[illegible]side, N.Y.
95263	Leecraft Mfg. Co., Inc.	[illegible] Island, N.Y.
95265	National Coil Co.	Sheridan, [illegible].
95275	Vitramon, Inc.	[illegible]port, Conn.
95348	Gordos Corporation	[illegible]field, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering	Marengo, Ill.
95712	Dage Electric Co. Inc.	Franklin, Ind.

TABLE 7-3 (CONT'D)

CODE LIST OF MANUFACTURERS (CONT'D)

Code No.	Manufacturer	Address
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96341	Microwave Associates, Inc.	Burlington, Mass.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Clif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99707	Control Switch Div. Controls Co. of America	El Segundo, Calif.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

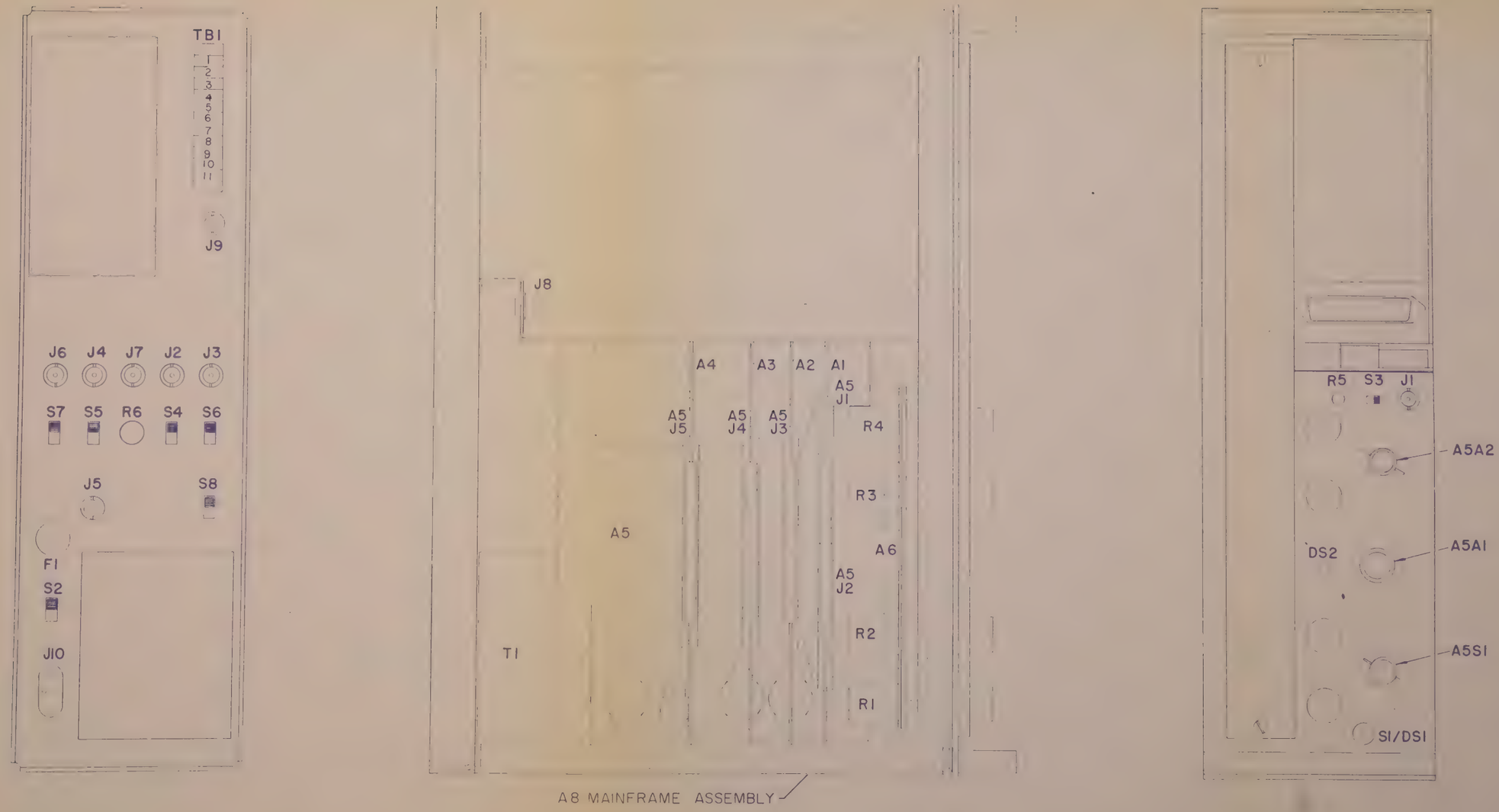


FIG 8-1

MAIN FRAME ASSEMBLY

MODEL 230A

TABLE 8-1

(FOR SYMBOLS NOT SHOWN IN THIS TABLE REFER TO MIL-STD-15)

SEMICONDUCTORS

DIODE, SEMICONDUCTOR

BREAKDOWN DIODE, UNIDIRECTIONAL

TRANSISTOR, NPN

TRANSISTOR, PNP

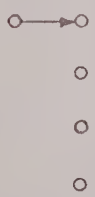
TRANSISTOR, FET

CAPACITIVE DIODE

CRYSTAL

SCR

SWITCHES



SWITCH, MULTIPOSITION NON-SHORTING

INPUTS, OUTPUTS & TERMINATIONS

SEPARABLE CONNECTORS (ENGAGED)

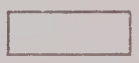
SIGNAL RETURN GROUND

LIKE DESIGNATED CIRCUIT RETURNS WITHIN A SINGLE SCHEMATIC ARE CONNECTED

CONTROLS & ADJUSTMENTS

SCREWDRIVER ADJUSTMENT

TEST POINT


ADJUSTMENT OR CONTROL LOCATED ON FRONT PANEL

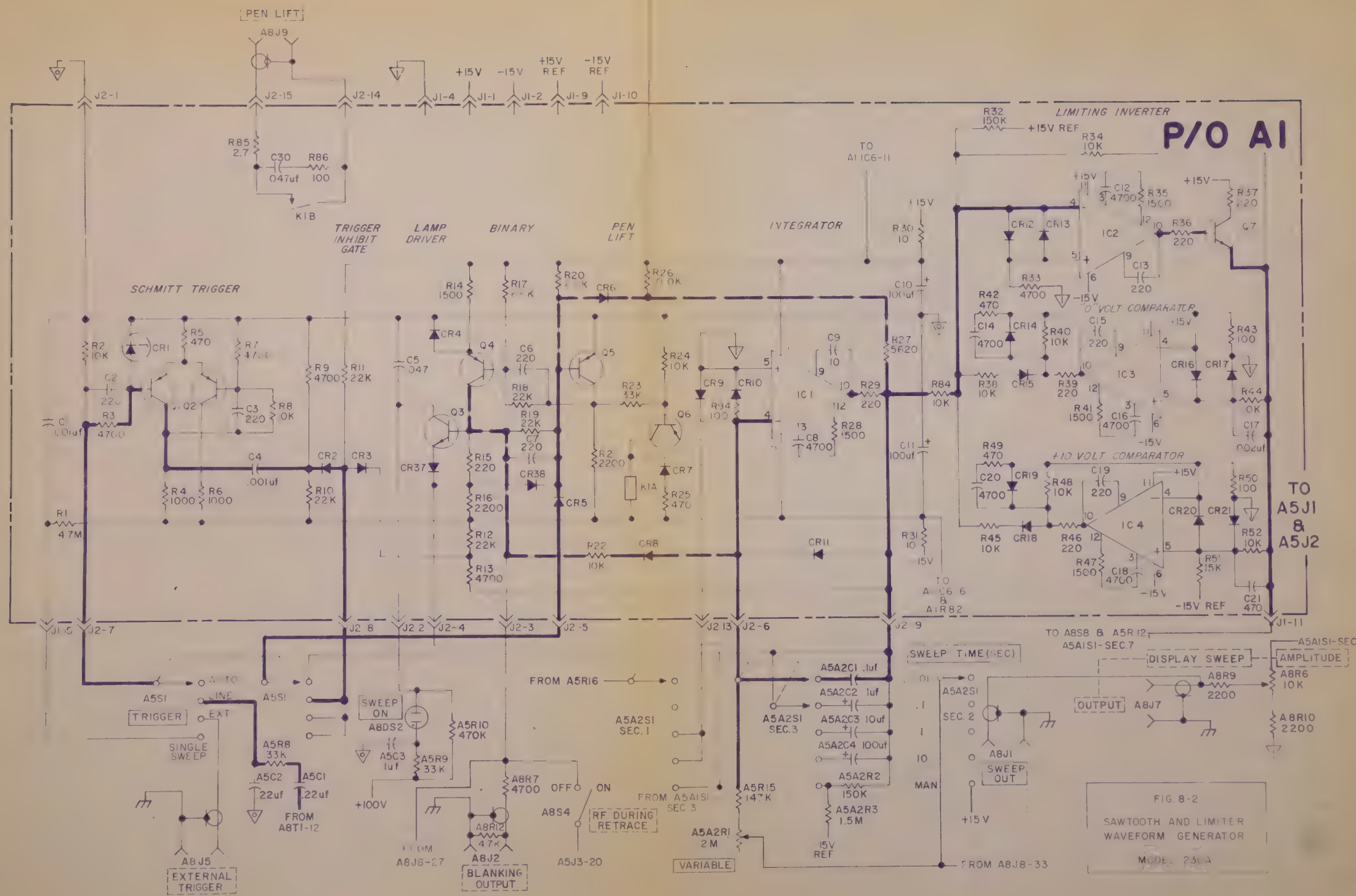
ADJUSTMENT OR CONTROL LOCATED ON REAR PANEL

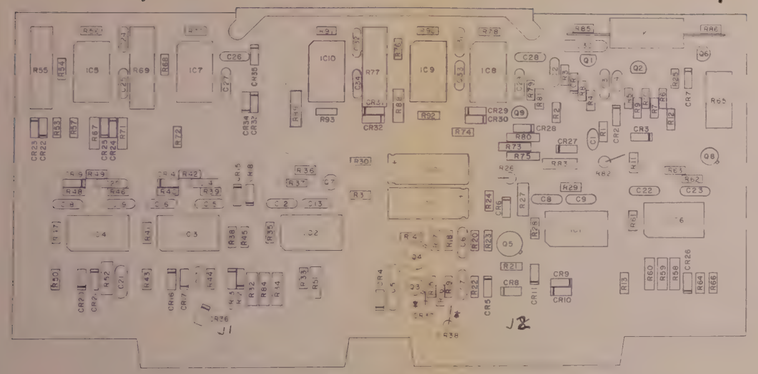
MISCELLANEOUS

SIGNAL PATH

FEEDBACK OR SUBSIDIARY SIGNAL PATH

NOTE: UNLESS OTHERWISE SPECIFIED, ALL CAPACITANCES ARE IN PICOFARADS, INDUCTANCES IN MICROHENRIES, AND RESISTANCES IN OHMS, 1/4 W, 10%


P/O A1
PEN LIFT
A8J9
+15V
-15V
+15V REF
-15V REF
J2-1
J2-15
J2-14
J1-4
J1-1
J1-2
J1-9
J1-10
R85 2.7
C30 .047uf
R86 100
K1B
TRIGGER INHIBIT GATE
LAMP DRIVER
BINARY
PEN LIFT
INTEGRATOR
LIMITING INVERTER
SCHMITT TRIGGER
R32 150K
+15V REF
R34 10K
TO A1IC6-11
R30 10
C10 100uf
R27 5620
R84 10K
R31 10
C11 100uf
TO A1C6-6 & A1R82
"0" VOLT COMPARATOR
+10 VOLT COMPARATOR
-15V REF
TO A5J1 & A5J2
R1 4.7M
R2 10K
R3 4700
R4 1000
R5 470
R6 1000
R7 470
R8 10K
R9 4700
R10 22K
R11 22K
C1 .001uf
C2 220
C3 220
C4 .001uf
CR1
Q2
CR2
CR3
C5 .047
R14 1500
R15 220
R16 2200
R12 22K
R13 4700
CR4
Q3
CR37
Q4
C6 220
R18 22K
R19 22K
C7 220
CR38
R20 10K
CR6
Q5
CR5
R22 10K
CR8
R24 10K
R23 33K
Q6
R2 2200
K1A
CR7
R25 470
R26 10K
C9 10
R94 100
R29 220
R28 1500
C8 4700
CR9
CR10
CR11
IC1
IC2
IC3
IC4
R33 4700
C12 4700
R35 1500
R36 220
R37 220
C13 220
Q7
CR12
CR13
R42 470
C14 4700
CR14
R40 10K
R38 10K
CR15
R39 220
R41 1500
C15 220
C16 4700
CR16
CR17
R43 100
R44 10K
C17 .002uf
R49 470
C20 4700
CR19
R48 10K
R45 10K
CR18
R46 220
R47 1500
C19 220
C18 4700
CR20
CR21
R50 100
R52 10K
R51 15K
C21 470
J1-5
J2-7
J2-8
J2-2
J2-4
J2-3
J2-5
J2-13
J2-6
J2-9
J1-11
TO A8S8 & A5R12
A5A1S1-SEC 7
DISPLAY SWEEP
AMPLITUDE
A8R6 10K
A8R9 2200
A8R10 2200
OUTPUT
A8J7
A5S1
TRIGGER
EXT
LINE
SINGLE SWEEP
A5R8 33K
A5C2 .22uf
A5C1 .22uf
FROM A8T1-12
A8J5
EXTERNAL TRIGGER
SWEEP ON
A8DS2
A5C3 1uf
A5R9 33K
A5R10 470K
+100V
A8R7 4700
A8R12 47K
FROM A8J8-27
A8J2
BLANKING OUTPUT
OFF
ON
A8S4
RF DURING RETRACE
A5J3-20
FROM A5R16
A5A2S1 SEC. 1
A5A2S1 SEC. 3
A5A2C1 .1uf
A5A2C2 1uf
A5A2C3 10uf
A5A2C4 100uf
A5A2R2 150K
A5A2R3 1.5M
15V REF
A5R15 147K
A5A2R1 2M
VARIABLE
FROM A5A1S1 SEC 3
FROM A8J8-33
SWEEP TIME (SEC)
.01
.1
1
10
MAN
A5A2S1 SEC. 2
A8J1
SWEEP OUT
+15V
FIG. 8-2
SAWTOOTH AND LIMITER WAVEFORM GENERATOR
MODEL 230A



A1 ASSEMBLY

A6 ASSEMBLY

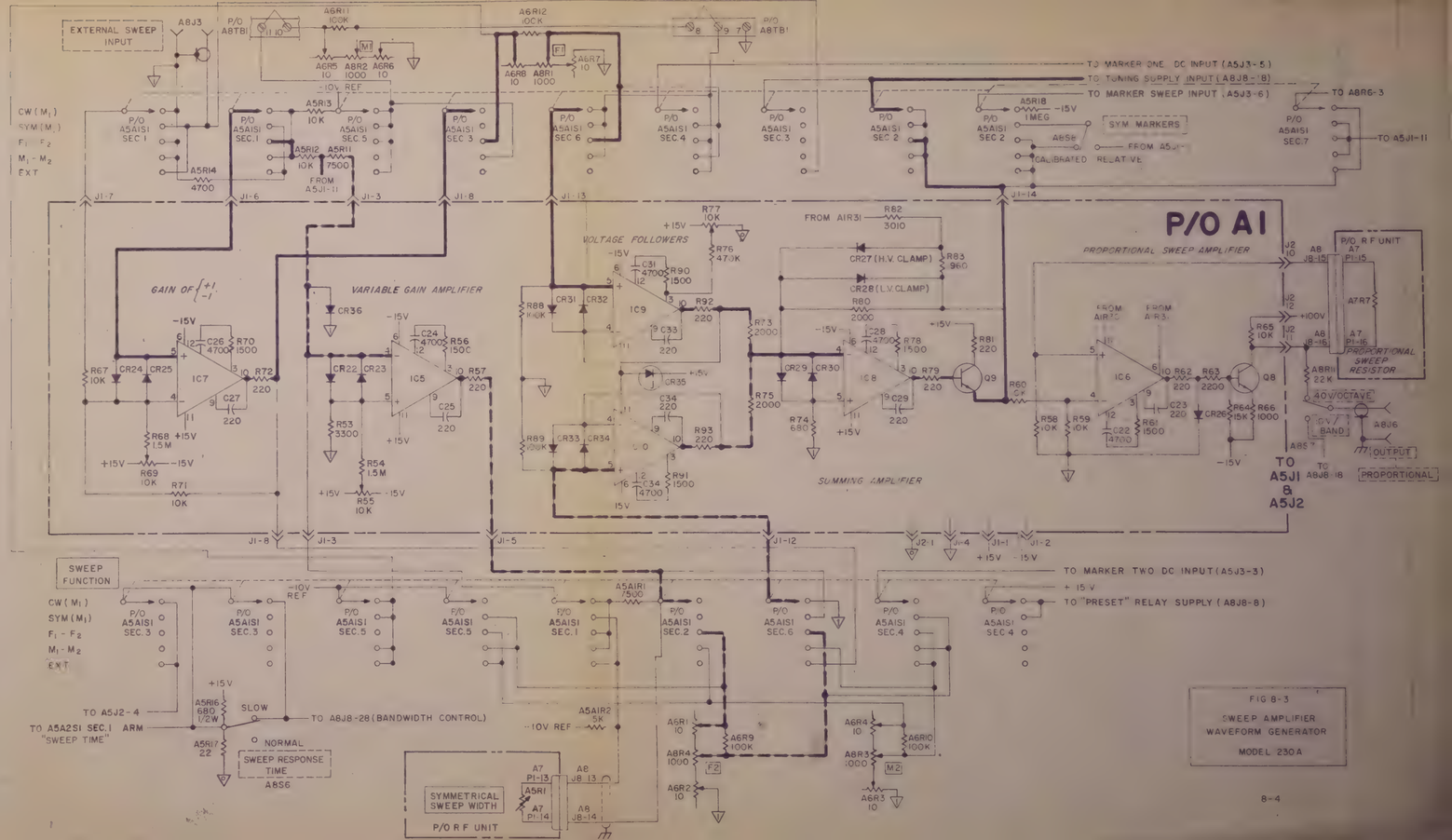
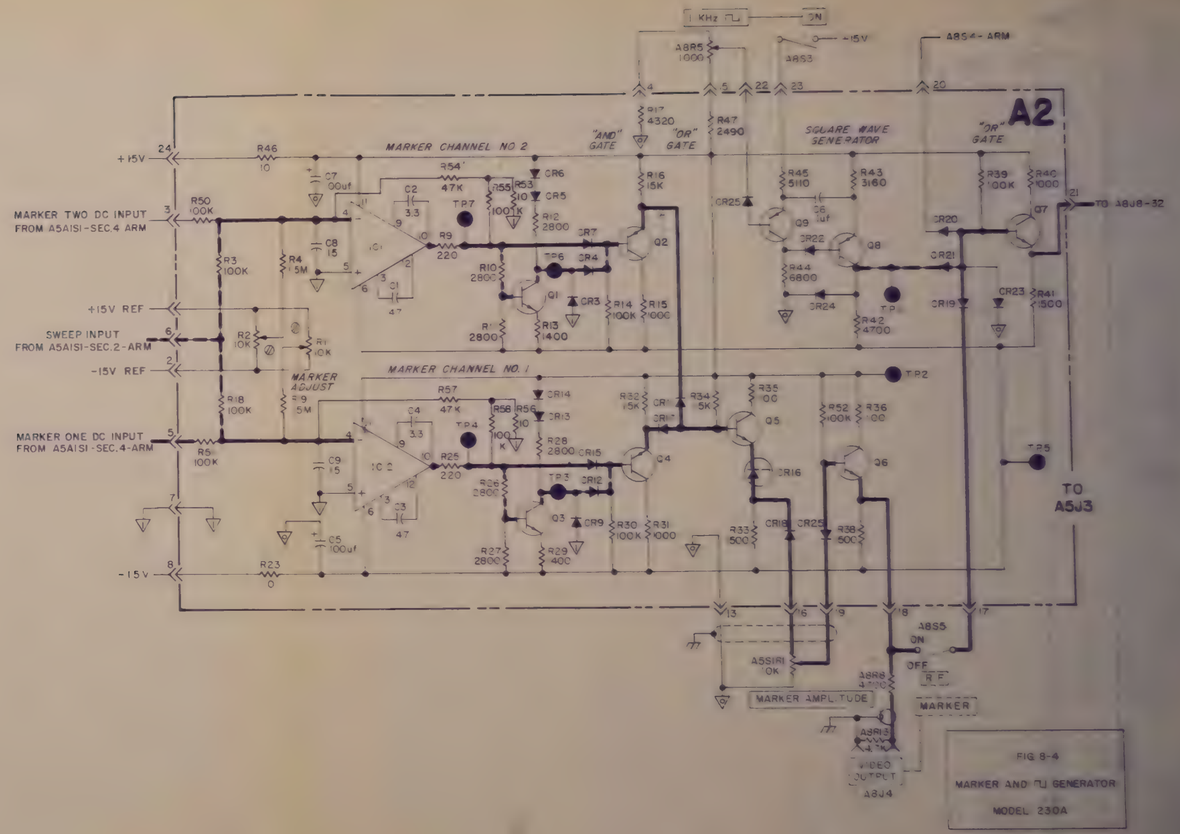
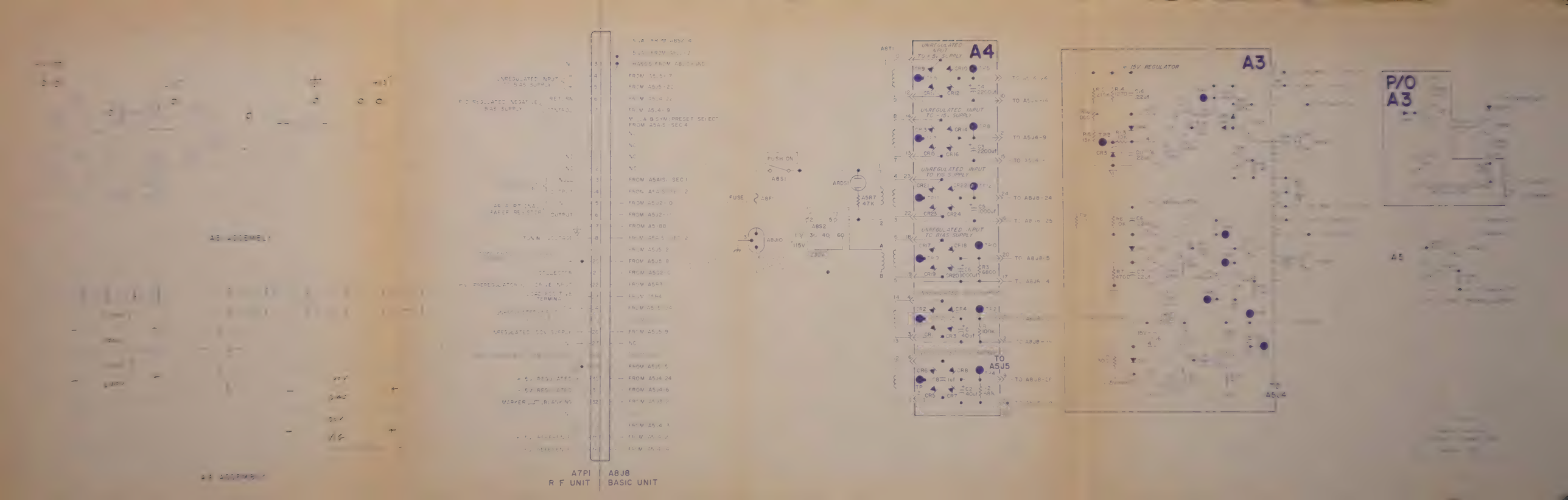


FIG 8-3
SWEEP AMPLIFIER
WAVEFORM GENERATOR
MODEL 230A

A2 ASSEMBLY


A2
MARKER CHANNEL NO. 2
MARKER CHANNEL NO. 1
"AND" GATE
"OR" GATE
SQUARE WAVE GENERATOR
"OR" GATE
MARKER ADJUST
MARKER TWO DC INPUT FROM A5A1SI-SEC.4 ARM
SWEEP INPUT FROM A5A1SI-SEC.2-ARM
MARKER ONE DC INPUT FROM A5A1SI-SEC.4-ARM
+15V REF
-15V REF
+15V
-15V
1 KHz FU
2N
A8S4-ARM
A8S3
A8S5
ON
OFF
RF
MARKER
A8R9
MARKER AMPLITUDE
A5S1R1
VIDEO OUTPUT
A8J4
TO A8J8-32
TO A5J3
FIG. 8-4
MARKER AND FU GENERATOR
MODEL 230A


A7P1
R F UNIT
A8J8
BASIC UNIT
A4
A3
P/O
A3
A5
A8J1
A8S1
PUSH ON
A8F1
FUSE
A8J10
A8S2
A8R7
47K
A8R51
TO
A5J5
TO A5J4
TO A8J8-24
TO A8J8-5
TO A8J8-25
TO A8J8-4
TO A8J8-2
TO A5J4-9
+15V REGULATOR
UNREGULATED INPUT TO +15V SUPPLY
UNREGULATED INPUT TO -15V SUPPLY
UNREGULATED INPUT TO YIG SUPPLY
UNREGULATED INPUT TO BIAS SUPPLY

SAWTOOTH & LIMITER

P/O A1

SWEEP AMPLIFIER

P/O A1

POWER SUPPLY RECTIFIER & FILTER

A4

POWER SUPPLY REGULATORS

A3

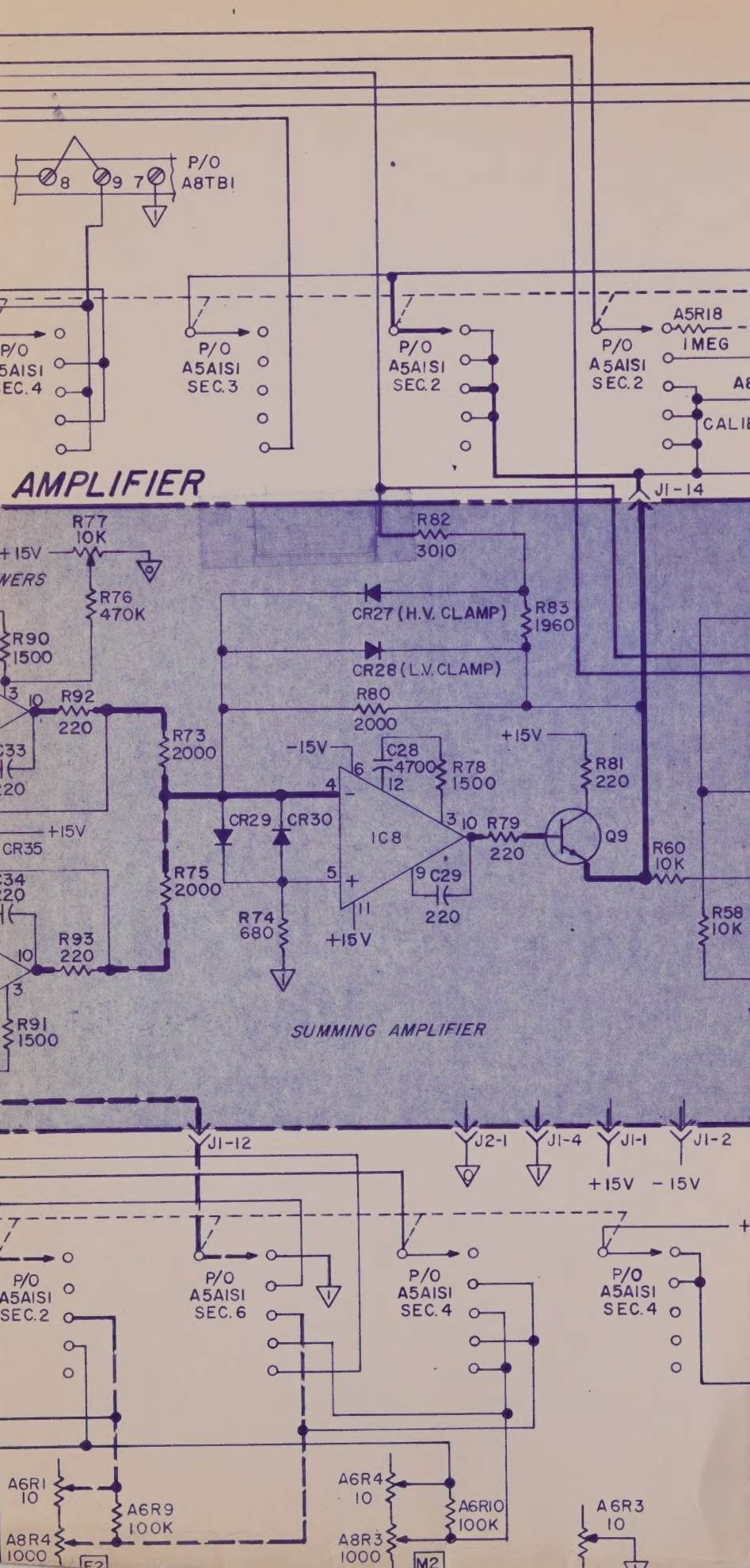
MARKER & ⊓ GENERATOR

A2

P/O A3

A5

OVERALL SCHEMATIC
MODEL 230A
SWEEP OSCILLATOR
MAINFRAME


P/O A8TBI
8
9
7
P/O A5AISI SEC. 4
P/O A5AISI SEC. 3
P/O A5AISI SEC. 2
P/O A5AISI SEC. 2
A5R18 1MEG
CALI
AMPLIFIER
J1-14
R77 10K
+15V
R76 470K
R82 3010
CR27 (H.V. CLAMP)
R83 1960
CR28 (L.V. CLAMP)
R80 2000
R90 1500
R92 220
R73 2000
-15V
C28 4700
R78 1500
+15V
R81 220
CR29
CR30
IC8
R79 220
Q9
R60 10K
CR35
R75 2000
C29 220
R74 680
+15V
R58 10K
R93 220
R91 1500
SUMMING AMPLIFIER
J1-12
J2-1
J1-4
J1-1
J1-2
+15V
-15V
P/O A5AISI SEC. 2
P/O A5AISI SEC. 6
P/O A5AISI SEC. 4
P/O A5AISI SEC. 4
A6R1 10
A6R9 100K
A8R4 1000
A6R4 10
A6R10 100K
A8R3 1000
A6R3 10

MP MASTER
MA35894